FOOD TECHNOLOGY

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August, 1956 Volume 10, Number 8

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IFT ACTIONS AND REACTIONS...

THE "CANADIAN" BREAKFAST—ST. LOUIS STYLE

Twenty-five Canadians went south of the border to attend the IFT's 16th Annual. And when 7:30 rolled around on Tuesday morning, June 12, the Canucks were delighted to see their atendance swelled by IFT officials and well-wishing members until the Breakfast count reached forty and there wasn't any more room. Then Bob Marshall, H. J. Heinz of Canada Ltd., Leamington, Ont., (and current Secretary of the Great Lakes Section) got the meeting started.

President Garnatz Welcomes Canadian IFTers. Dr. George F. Garnatz, President-elect (now President of IFT) was the first to speak. In a few well-chosen remarks, he recalled visits he had made to Canada and how he had enjoyed them. He welcomed the Canadians to St. Louis and said he was at their service. He admitted that taking on the IFT Presidency was a big job and aimed to do the best he could with the responsibilities that would shortly be coming his way. He got a great ovation.

Col. Charles S. Lawrence, IFT Executive Secretary, followed Dr. Garnatz with some appropriate remarks concerning the drawing of boundaries when it came to assigning Ontario IFT members to either the Western New York or Great Lakes Sections. However, he said, it wasn't an issue but rather it was a hope that some day these members in Ontario and Montreal, for that matter, might have a section of their own. Col. Lawrence got a big hand from the breakfasters. Then Chairman Marshall called upon Mr. C. Hamilton Kenney of the Canada Dept. of Agriculture's Information Service (who has also been an associate editor of FOOD TECHNOLOGY since 1950, handling Regional Section News) to say a few words. Mr. Kenney based his remarks on facts from the IFT 1956 Directory. He pointed out that comparatively speaking Australia had more IFT members than Canada, something like 116 to 105. In Australia, some 96 firms employ food technologists who are members of the IFT while in Government departments there are 16 with 4 at Universities and Research Institutes; the corresponding Canadian figures are 72 firms, 28 in Government and 5 in Universities and Research Institutes. Australia had two IFT Sections and Canada one. Looking at the overall international membership, the IFT had members in 43 foreign countries. Mr. Kenney said that he had often been asked how many IFT members there were in Canada and—now that he'd been able to obtain the 1956 Directory with its international breakdown of membership—he had found the answer. It was interesting to note that Australia had more members than Canada—and more Sections too. Then came Mr. L. J. "Jack" Frost, Manager of the Research Department of the Continental Can Company of Canada, rising gracefully to his feet. . . . He wondered if the day would come when the IFT might hold its Convention in Canada. He had in mind Montreal, and added that since Ottawa—Canada's Capital—was considered by many Montrealers as "a suburb of Montreal," then a day of the Convention could very nicely consist of a special excursion to Ottawa and visit to Government research institutions. Perhaps it was only a dream, still it was something for Canadian IFT Members to think about. Following his remarks there was considerable discussion. American friends at the Breakfast voiced wholehearted approval of the idea for an annual meeting to be held in Canada. Those present from Canada thought such a meeting, if it could be organized, would be a beneficial event. Dr. C. Olin Ball, Rutgers University, and Editor Emeritus of FOOD TECHNOLOGY, was last to speak, saying that he always enjoyed attending the "Canadian Breakfast" and meeting friends from Canada.

C. H. Kenney . . .
after-breakfast speaker

R. B. Marshall, H. J. Heinz Co. of Canada, Leamington; Col. Chas. S. Lawrence, Exec. Sec'y IFT; and Dr. John Mahon, Food & Drug, Ottawa (seated) getting tips on the stock market from Jack Frost, Continental Can Co. of Canada, Montreal.

The "Breakfast" wound up with Bob Marshall being re-elected Chairman of next year's "Breakfast" which, of course, will be held in Pittsburgh. Al Klopp of Griffith Laboratories, Toronto, was elected Secretary of the 1957 Breakfast Meeting when it was planned to have all members of the IFT in Canada contacted by mail reporting developments in connection with next year's Breakfast meeting.

Those from Canada attending this year's IFT St. Louis Meeting included: L. S. White, Aylmer Food Products, Hamilton; Paul C. Trussell, B. C. Research

(Continued on page 6)

CONTINENTAL *Landmarks*

Periodic progress reports of interest and value to the food processing field

Advantages of wrap-around lithography extended to full line of frozen concentrate cans

Introduced by Continental in 1954, the 6-oz. cemented side seam can was an instant success. By doing away with the space-consuming soldered seam, our scientists and engineers made it possible to cover the entire can surface with eye-appealing lithography – at no increase in cost.

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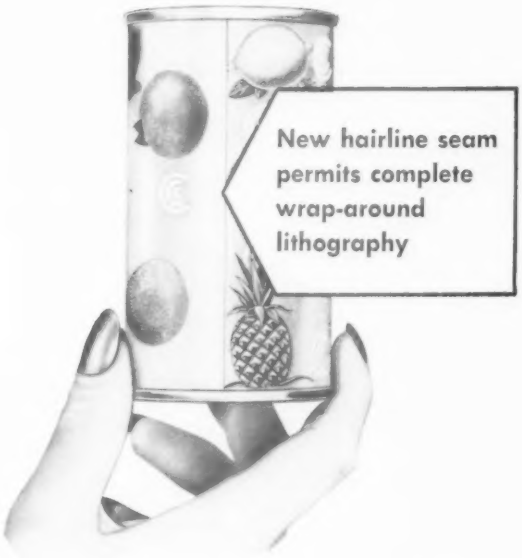
The performance of these cans has been proven on all types of freezing equipment and in all can-handling systems. The availability of a full family of solderless cans is one of the many strides Continental is making under its tailor-made packaging program. You may expect even more rapid developments in cans and canning methods now that our multi-million-dollar Metal Division research and development center is in full operation.



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Lemonade Base Concentrate, Frozen
Limeade, Frozen
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WHY SHOULD THE VITAMIN C CONTENT OF FRUIT AND VEGETABLE JUICES BE STANDARDIZED?

Because nutrition reports disclose that—

- **Vitamin C deficiencies exist throughout the country***
- **Scurvy has not disappeared from the United States***

Proof of deficiencies among adults and children. You should know these facts!* Diet surveys from Maine and Vermont, New York, Illinois, New Mexico, Oregon, West Virginia, and Texas show a definite pattern of inadequate vitamin C intake. These studies covered grade school and high school children, college men and women.

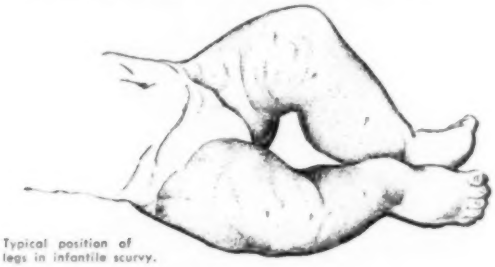
Spongy, swollen gums symptomatic of scurvy.

From these studies* of dietary habits and physical conditions there is considerable proof that many of the children and adults covered by survey have actual, physical symptoms of vitamin C deficiency.

Infantile scurvy. Scurvy* occurs, even today, among infants who are artificially fed. Fortunately the disease may be cured by the administration of vitamin C. How much more sensible it is to prevent it by supplying these bottle-fed infants with the daily allowance of 30 milligrams of vitamin C as recommended by the Food and Nutrition Board of the National Research Council for children under one year of age.

Symptoms of infantile scurvy are fretfulness and fear of being touched.

These bottle-fed infants, unless receiving a pediatric prescription containing vitamin C, are largely dependent on supplemental ascorbic acid which they receive from fruit or vegetable juices. Unless fortified with vitamin C many of the processed juices may not supply these babies with adequate quantities of this essential element.



Typical position of legs in infantile scurvy.

What can be done? Because of the increasing evidence that American diets are deficient in vitamin C, leading nutrition experts believe that processed fruit and vegetable juices, on which the public is so reliant for its supply of this necessary vitamin, should contain the "Vital Ingredient."

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*Statements are based on documented reports. References on request.

Illustrations after photographs in The Vitamins in Medicine by Bicknell and Prescott, Third Edition, published by Grune & Stratton, Inc., New York.

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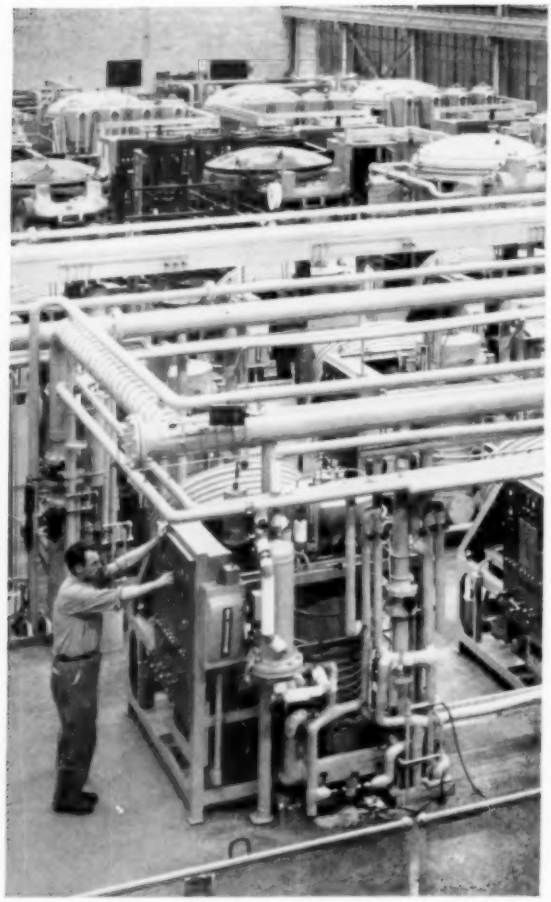

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(Continued from page 2)

Council, Vancouver; Dave Anderson, Burns & Co., Calgary; John Dempster, Grain Research Laboratory, Winnipeg (who gave a paper) from Toronto; Bill Brechin, E. J. Dufault, of Canada Packers Ltd., Herb Aitken, Canada Vinegars Ltd., John Wenzel and Al

Row 1. Jean David, Horticulture Division, Que. Dept. of Agriculture, Montreal; Dr. Geo. Garnatz, Pres.-elect, IFT, Herb Aitken, Canada Vinegars, Toronto; Al Klopp, Griffith Lab, Toronto; and Chas. Harrold, Chairman, St. Louis Program Committee.

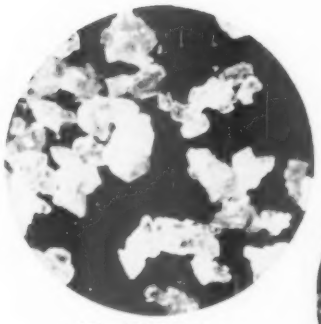
Row 2. Bill Brechin and E. J. Dufault, Canada Packers Ltd., Toronto; Larry White, Canadian Canners Ltd., Hamilton; T. J. Keefe, Stange-Pemberton, Toronto.

Row 3. Dr. John Barlow, Shirriff-Horsey Corp., Toronto; John Wenzel, Griffith Lab, Toronto; Dr. C. Olin Ball, Rutgers U. and Editor Emeritus, FOOD TECHNOLOGY; Robert Carson, Chemistry Div., Can. Dept. of Agric., Ottawa.

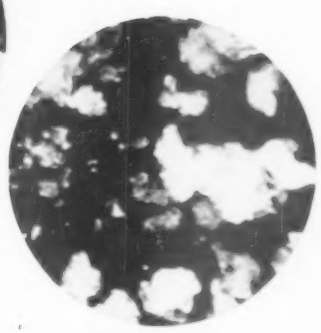
Row 4. Ken Shaw, H. J. Heinz Co. of Canada, Leamington; Dr. Alec H. Jones, Food Microbiologist, Can. Dept. of Agric., Ottawa; Keith Torrie, Pure Spring Co., Ottawa; and Dr. Ed Asselbergs, Horticulture Division, Can. Dept. of Agric., Ottawa.

Klopp, Griffith Laboratories, Dr. John Barlow, Shirriff-Horsey Corps., and T. J. Keefe, Stange-Pemberton Ltd.; from Montreal, L. J. Frost, Continental Can Co. of Canada and Jean David, Quebec Dept. of Agriculture; from Ottawa, Major Grant Armstrong, Dept. of National Defence; Dr. John Mahon (who gave a paper) and Ross Garrison from the Dept. of National Health and Welfare, Food and Drug Division; Dr. A. H. Jones, Dr. Ed Asselbergs, Bob Carson, Bill Humphrey, and C. H. Kenney, all with the Canada Dept. of Agriculture, and Keith Torrie, Pure Spring Co. ltd. Bob Marshall and Ken Shaw from the H. J. Heinz Co. of Canada, Leamington, and Danny Steele from Stokeley-Van Camp of Canada, Essex, were also present.

(Continued on page 8)



Vitamin A Acetate



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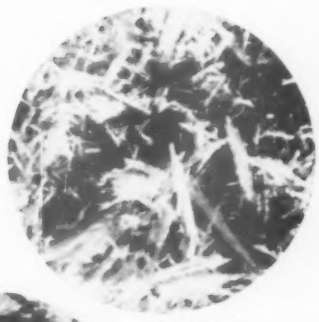

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and some we just study

These forms of vitamin A we have made, not for money but for curiosity. All we have made of them has been used up in various experiments. However, if some chemist wants some, we will happily send him a collection of six reprints from the *Journal of the American Chemical Society*. From the papers he ought to be able to figure out how to twist vitamin A for himself into these odd geometrical isomers.

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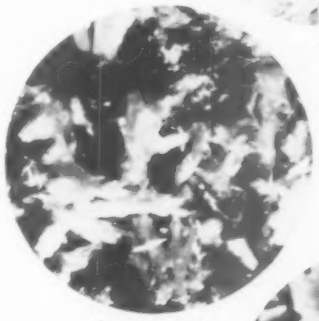
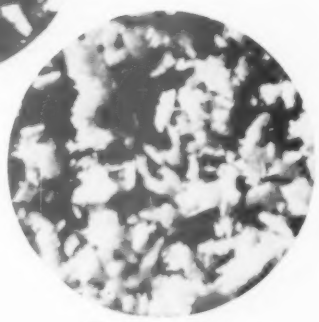


6-cis-Vitamin A



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All illustrations are 15× photomicrographs of crystals of the various vitamin A esters and isomers.

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(Continued from page 6)

Finally, a word of thanks to Chuck Harrold, St. Louis Program Committee Chairman, and his colleagues for the fine handling of the "Canadian Breakfast" arrangements. —*Contributed*

AUSTRALIA AWARD TO ROBERT S. SCULL GIVEN IN ABSENTIA AT SIXTEENTH ANNUAL MEETING, ST. LOUIS

For "outstanding efforts to promote the exchange of ideas in the field of Food Technology, thus contributing to international understanding," Robert S. Scull, Portland, Maine, long active in such enterprises and presently in the Far East for a kindred purpose, was awarded *in absentia* a sterling silver tray, appropriately inscribed, to signalize his achievements. Donor of the Award, the Australia Northern and the Australia Southern Regional Sections of IFT, established the prize in 1955 and Mr. Scull is the first recipient.

Receiving the Australian Award on behalf of Robert S. Scull is Dr. Maynard A. Joslyn, Northern California (left), proxy for Mr. Scull; Awards Committee chairman, W. Ray Junk (right) presented the beautiful sterling silver tray, the Award gift, and Dr. Joslyn made the response.

Robert S. Scull was one of the early technologists employed by the American Can Company when service to packers was introduced by the Research Department. After a few years in this service he was employed as production manager for Burnham and Morrill, Portland, Maine; at the time he left this company he was Vice-President for Research and Development.

During World War II he served in Australia as the only American civilian employee of the A.N.S. and was instrumental in developing the successful processed food production program instituted there, particularly in the field of canning technology. Following this he was selected for a special mission to appraise food processing developments in Germany; then served as food technologist assigned by the State Department to assist Greece. Subsequently he was sent on missions to Brazil and Jordan.

SECOND OSU FOOD TECHNOLOGY ALUMNI LUNCHEON HELD JUNE 12 IN ST. LOUIS, MO.

Food technologists, alumni and staff members of Ohio State University attended their second annual luncheon at the 16th Annual Institute of Food Technologists' Meeting in St. Louis, June 10-14. Twenty-five persons were present at the luncheon served in the Sheraton-Jefferson Hotel, June 12.

Dr. Rees B. Davis was toastmaster. (Incidentally, he made the arrangements for the luncheon.) Dr. Inez Prudent reported briefly on the present status of research in the Home Economics Department, and related that expansion of the classroom facilities were imperative to fill the needs resulting from increased student enrollment. Dr. Fred Deatherage told several of his very interesting experiences during his recent trip around the world. The most revealing fact about Dr. Deatherage's trip was that wherever he visited, Ohio State Alumni or friends of Ohio State were always present to greet him and show him the interesting, out-of-the-way sights of their country not customarily visited by the casual traveler. Dr. H. D. Brown commented on current research being conducted by the staff members of the Horticultural Products Division of the Department of Horticulture. Dr. Ray Blackmore, Horticulture Department, Ohio State University, was elected secretary and also made chairman for the 1957 OSU Alumni Luncheon to be held in Pittsburgh in June.

YOU . . . AND YOUR FOODS [a]

Golden Anniversary of a Law. This year marks the fiftieth anniversary of the Food and Drugs Act and the Meat Inspection Act of 1906 . . . the beginning of Federal protective legislation which, down the years, has been of increasing benefit to everybody in the United States.

For half a century there has been evolving an ever firmer, friendlier and more effective partnership of government and the industries which produce our foods, drugs and cosmetics. An outstanding example of free capitalism under public control—of "liberty in law"—this partnership has grown throughout the land. The Federal laws and regulations greatly influence the laws and regulatory systems of all states and territories.

Through this framework of cooperation, the U. S. Food and Drug Administration, Department of Health, Education and Welfare; the Meat Inspection Branch of the U. S. Department of Agriculture, and the state and local enforcement agencies are able to work closely with industry to assure 167 million Americans the most wholesome food and the purest and safest drugs in the world.

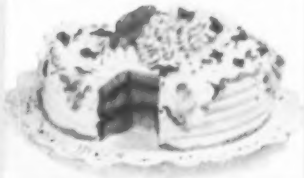
Progress—and Problems. Even before 1900 the food industry was making great progress in the preservation and distribution of its products. Canning was moving from the home kitchen to large factories, and more and more markets were offering canned corn, tomatoes, asparagus, and pineapple.

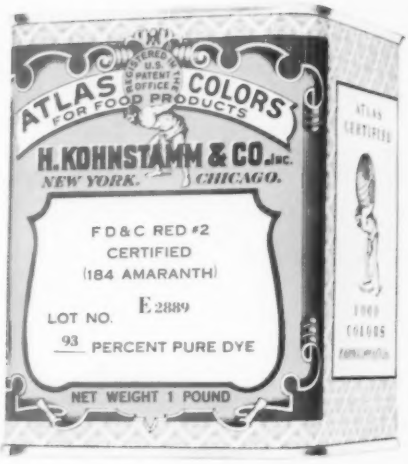
Food packers were experimenting with new chemi-

[a] This article consists of excerpts from the booklet, "You . . . and Your Foods, Drugs and Cosmetics," prepared by the 50th Anniversary Committee of the Association of Food and Drug Officials of the United States. Permission to reprint this material was granted by the Committee.

(Continued on page 10)

FOOD NEEDS COLOR





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(Continued from page 8)

cal preservatives. They found that such time-honored ingredients as salt, sugar, and vinegar were not the only chemicals they could use to improve the keeping quality, color, and flavor of perishable foods. Unfortunately, limitations of technology resulted in the use of certain "chemical antiseptics" which were of questionable safety. Some were actually poisonous.

Enter Dr. Wiley. State chemists had been among the first to advocate a Federal food and drug law. They found a fighting champion in 1883 when Indiana's State Chemist, Dr. Harvey W. Wiley, came to Washington. He was appointed Chief Chemist of the United States Department of Agriculture. From that position he directed a campaign of food and drug enlightenment whose beneficial effects are still felt everywhere today.

As Chief Chemist, Dr. Wiley was deeply concerned about certain commercial foods which owed their keeping qualities to formaldehyde, salicylic acid, and other chemicals. Were these foods safe and wholesome when they reached the home kitchen and dining table? Dr. Wiley proceeded to find out. In his famous "poison squad" experiments, a group of young volunteers ate foods containing measured doses of the suspected chemicals and reported their symptoms. These experiments, given wide publicity, dramatized the need for Federal control.

Dr. Wiley's crusade was strongly supported by responsible members of the food and drug industries and by authors, magazine writers, and newspaper reporters. Women's organizations were particularly helpful in telling the public why "there ought to be a law."

Finally, after much debate, Congress responded to the public will, and on June 30, 1906, President Theodore Roosevelt signed the Food and Drugs Act and the Meat Inspection Act.

But New Legislation Was Needed. The Food and Drugs Act of 1906 was unquestionably the strongest in the world for its time. But time sped on, bringing important discoveries in medicine and nutrition . . . remarkable advances in the production of crops and livestock . . . in the manufacturing, processing, and distribution of foods and drugs.

In a few years the 1906 law was lagging behind the growth and progress of industry. Homemakers found they needed more precise information about ingredients than the law required. Industry saw the need for official standards for such everyday foods as canned fruits and vegetables; new standards of inspection for factories, packing plants, and warehouses.

The "Pure Food and Drug Law," as it was popularly known, went into effect in 1907. During that year enforcement officials set up laboratories over the country, appointed inspectors to collect samples of foods and drugs, and devised new methods of testing them. Meanwhile the food and drug industries were preparing labels to conform with the new law, which required that consumers be given certain information needed for intelligent buying.

The Food, Drug, and Cosmetic Act. Again, as in 1906, government, industry, and enlightened citizens urged the passage of protective legislation. They wanted a law stronger and more comprehensive than the original "Pure Food and Drug Law."

In 1938, Congress passed the present Food, Drug, and Cosmetic Act, which corrected most of the weaknesses of the Act of 1906.

The purpose of the present law is to insure that foods, drugs, therapeutic devices and cosmetics shipped in interstate commerce, or imported into the country, are pure and wholesome, safe to use, made under sanitary conditions, and truthfully labeled. As an additional safeguard, the safety of every new drug must be proved to Food and Drug Administration scientists before it may be marketed.

Since 1938, FDA scientists have evaluated more than 10,000 applications for the sale of new drugs and have passed more than 7,000.

What the Label Tells. To a large extent, the Federal Food, Drug, and Cosmetic Act works through the medium of the label. The Act requires that labels, or inserts in the package, give information which helps consumers to buy and use foods, drugs and cosmetics with safety and satisfaction.

The label tells consumers what they are buying and exactly how much . . . the name and address of the responsible manufacturer, packer, or distributor.

The label tells the truth—in plain sight and plain words. Olive oil, for example, must not contain any other oil. Black pepper must be pure black pepper; or, if an imitation, it must be so labeled. In processed foods, ingredients must be listed in the order of their predominance.

Containers must fit the contents. A can holding seven ounces of sardines, or any other food, must be the appropriate size for seven ounces; not so large that it could hold twice that amount, and possibly mislead the purchaser.

Labels on foods enriched with vitamins—bread, milk, margarine, baby foods, pet foods and many others—must state the vitamin content.

Official standards are established for such foods as bread, canned fruits and vegetables, tomato catsup, jams, jellies and preserves. Consumers, incidentally, may take part in deciding how much fruit, sugar and other ingredients go into grape jelly, strawberry preserves and similar foods long associated with "that good home-made flavor."

Food standards are set in the best democratic tradition. The FDA holds public hearings and questions housewives on articles of food. It tests hundreds of samples and hears testimony from its own officials and representatives of industry.

When all the evidence is in, the standard for a specific food item is defined on the basis of fair practice. For example, the problem of the contents of strawberry jam was settled at a public hearing when it was decided that traditional usage had set the precedent. Fruit jams and jellies should properly contain 45 parts fruit or fruit juices to every 55 parts sugar.

Setting a food standard is no quick or easy job. The record of the hearings dealing with bread standards covered 17,000 pages!

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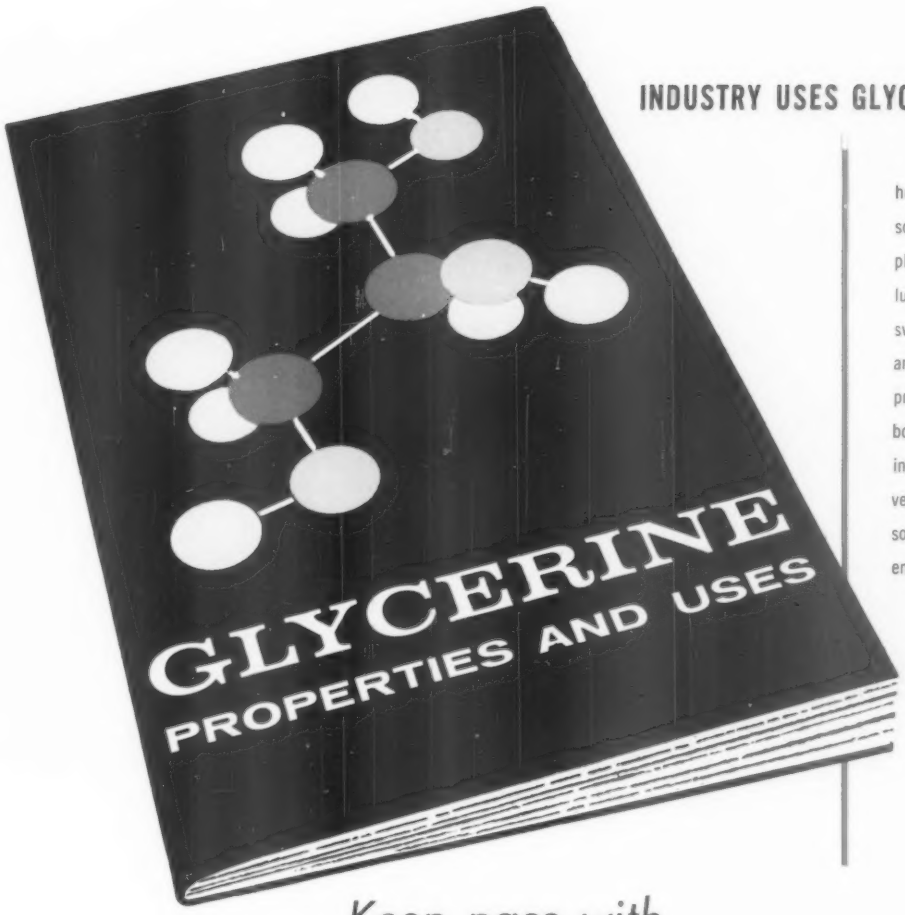

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(Continued from page 10)

Meat Inspection. Probably most homemakers are familiar with the round purple stamp which indicates that meat has been "U. S. Inspected and Passed." Regulation of interstate business in meat comes under the Meat Inspection Act, which requires Federal inspection of all meat shipped in interstate or foreign commerce, and inspection of processing plants.

Canned, processed, and packaged meats also come under the supervision of the Meat Inspection Act. Labels are required to give a name that adequately describes the product, to list ingredients in decreasing order of predominance, to give the net weight, and the name and address of the manufacturer or distributor.

Keeping the Law Up to Date. Probably no law can keep abreast of today's swift changes in foods and drugs. As pointed out recently by a Citizens Advisory Committee which reviewed the work of the Federal Food and Drug Administration, "a revolution is occurring in the field of food technology, exemplified by new chemical additives, radiological sterilization, and 'cooked ready-to-serve' and frozen foods."

New insecticides contribute indirectly to better food crops . . . hormones used in livestock feed reduce the cost of production.

In the drug field, the use of endocrine products, barbiturates, sulfonamides, and vitamins is steadily increasing . . . there is continuous and rapid development of new life-saving drugs that were undreamed of only a few years ago.

Scientists are indeed giving us better foods than ever before—and a longer lifetime in which to enjoy them. But new foods and medicines present difficult problems for industry and government, and particularly for those charged with enforcing food and drug laws.

Amendments to the 1938 Act. While its complete revision has not been necessary, the 1938 Act has already been amended a number of times. These amendments include laws to:

Require government testing and certification of the safety and efficacy of penicillin and other antibiotics before they are put on the market;

Define the kinds of drugs which cannot be used safely except under medical supervision, and which may only be purchased on the prescription of a licensed practitioner; and

Require under the Miller Amendment that chemicals be pre-tested to insure safe limits for the amounts left on fresh fruits and vegetables as the result of farmers' spraying and dusting for better products.

Regulations at State and Local Levels. Much of the responsibility and work of enforcing pure food and drug laws fall on the shoulders of state and local officials, since Federal law does not reach products consumed in the same states where manufactured. State authorities in the field were among the first to get behind Dr. Wiley's crusade for federal measures.

Twenty-six states have adopted food, drug and cosmetic laws patterned after the present Federal law. Other states are currently considering such legislation. Uniformity in such laws is advantageous to consumers and industry alike, since it eliminates the hardship of meeting different state requirements.

Citizens Advisory Committee. In 1955 a Citizens Advisory Committee, composed of 14 outstanding men and women from government, industry, labor, education, law, and consumer groups, made a careful survey of the Food and Drug administration and its needs. They found, after a thorough investigation, that the agency's present resources are "woefully inadequate to discharge its present responsibilities."

New processed and packaged foods . . . new drugs . . . new pestictides . . . are growing rapidly in number and volume—adding new and complex problems to the work of safeguarding foods and drugs, and taxing the limited resources of the Food and Drug Administration. New amendments to the 1938 Act have added an extra load of work for enforcement officials. Among the Advisory Committee's major recommendations for strengthening the Food and Drug Administration were increased appropriations, increased personnel, much-needed equipment, and a modern building.

The Consumer's Responsibility. This commemorative year is a good time for consumers to get acquainted with the local, state, and Federal laws that protect the nation's health by safeguarding food and drug supplies.

It is a good time to get behind recommendations made to strengthen the resources of the Federal Food and Drug Administration, and state food and drug departments, so they can keep abreast of scientific advances in food and drug technology and with other developments that promise to be almost unlimited in their benefits to mankind.

Maintaining the high standards of wholesomeness and purity of America's foods, medicines, and cosmetics is an exacting and never-ending task. It requires the wholehearted cooperation of government, industry, and responsible citizens everywhere.

USDA FOOD TABLE—ONE ON YIELDS—TO BE ISSUED SOON

USDA food-composition tables for various nutrients or classes of foods have long been standards of reference. Another table, soon to be published, is "Food Yields—Summarized by Different Stages of Preparation." According to *Agricultural Research*, April, 1956, it shows how much the meat, fruits, vegetables, and other foods purchased in the market can be expected to yield as food ready to eat.

This information on yield and different kinds of preparation loss will help dietitians and food managers gauge quantities in the course of planning food purchasing for school lunchrooms, hotels, and restaurants, for the Armed Forces, and for hospitals and other institutions. Home economists and family food managers will use the table in preparing food budgets and market lists when getting most nutritive value for money spent is all important. Researchers also need to know food yields when computing nutrients in foods as eaten, in making nutrition or dietary surveys, or in evaluating diets.

(Continued on page 14)

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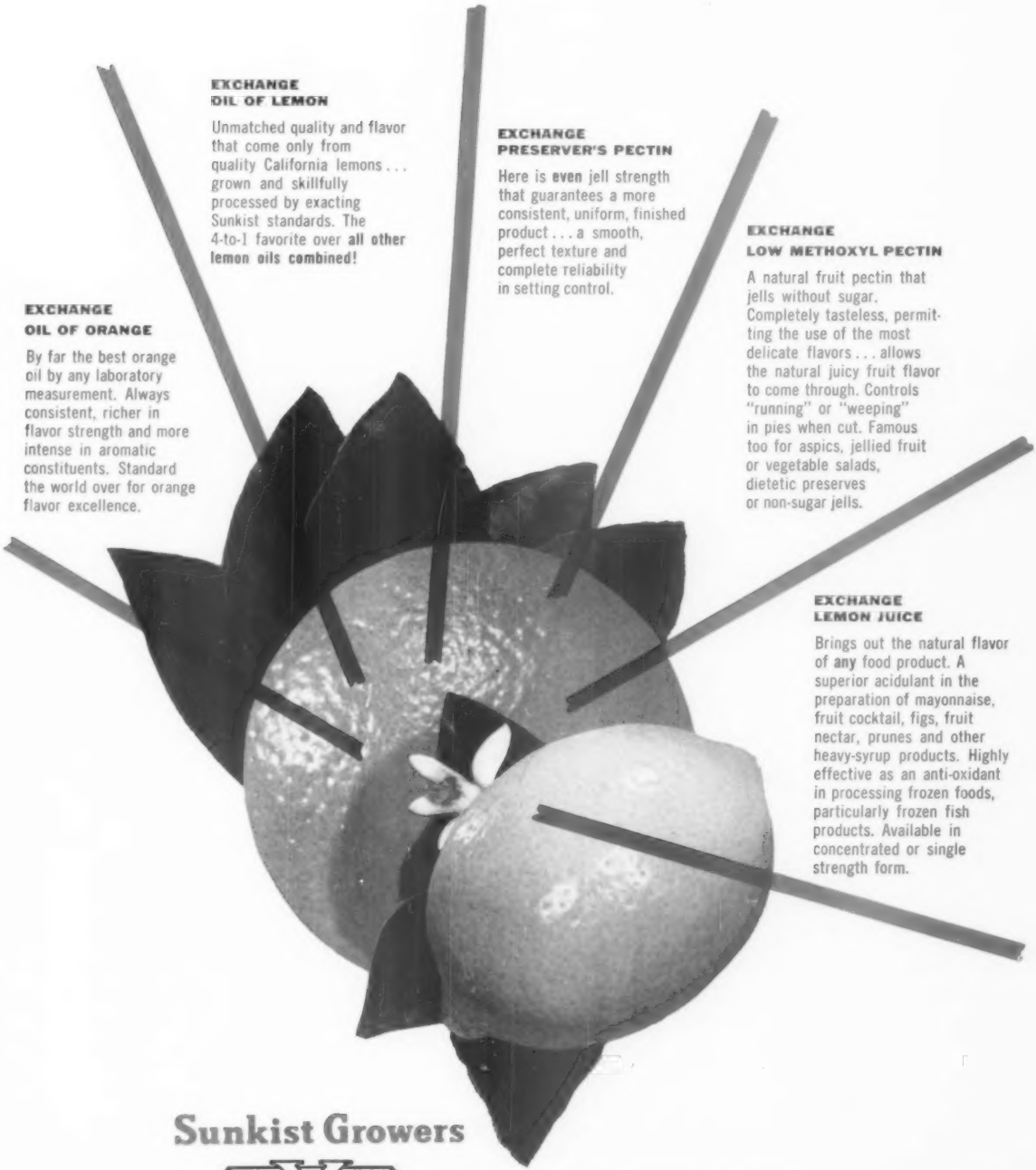

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(Continued from page 12)

USDA nutrition analysts for the past 60 years have provided general figures for estimating food yields, as part of the over-all study on food composition. But this is the first time that such figures have been brought together in a special tabulation.

In compiling this table, the nutrition analysts made a special search for data originating in the United States since 1940. Newer data reflect present-day marketing practices of trimming vegetables and prepackaging produce and meat, as well as the effect of new varieties and breeds. More detail is given in this publication on the amount of refuse—pits, bones, shells, skins—and of waste due to spoilage and trimming than was reported years ago. Moreover, many of the recent data have been collected under practical working conditions in institutions and private homes, and more nearly represent present-day products and practices than some of the earlier figures published.

New also are figures on weight losses and gains during cooking — evaporation and drippings in meats, evaporation in vegetables, and absorbed water in cereal products.

Yield data came from many sources. Some are by-products of ARS work planned for other purposes—chemical analysis of foods, canning, dehydration, and freezing, development of recipes, and household use in relation to quality. Marketing studies to determine yield of meat cuts and poultry supplied data, as did the Armed Forces boneless-beef study (*Agr. Res.*, March, 1956, p. 15).

Other figures came from experiments of the Fish and Wildlife Service on methods of processing and cooking fish, from Navy studies on fresh and processed vegetables, and from work in the Food and Drug Administration, universities, and experiment stations. Meat-packing houses and other commercial and industrial concerns contributed a great deal of data.

The compilers ran into many problems—in some cases the nutrition analysts felt that the number of food samples was not large enough to give reliable averages —especially of bone, skin, and other losses in meats after cooking. A few foods are not listed at all because there are no data available on them at the present time.

To fill these gaps in data on physical yields—as well as others on nutrient content of foods—ARS invites researchers to send in data on composition as work is completed. Food composition tables will be revised from time to time as more and better data become available.

IN RETROSPECT AND PROSPECT [a]

GEORGE F. GARNATZ
President of the Institute of Food Technologists

Food has been a matter of primary concern to man from the days of his nomadic existence through the era when he settled down to follow agricultural pursuits to provide for his own requirements, up to the present highly industrialized period where, as in the United States for example, his food is made available to him by specialists engaged in the production, processing and distribution of his food needs. Nevertheless, in a sense, man accepts his food with a measure of casualness. He enjoys the experience of eating. He finds congeniality in sharing the experience with others. He is not unresponsive to the esthetic qualities of food. On the other hand, he takes for granted and is relatively lacking in his appreciation of what is done to bring food to him.

He takes great pride in his ownership of the many mechanical devices provided to make living more comfortable and convenient, to provide him with entertainment and to make the wide outdoors his playground. He concedes to those who build these gadgets the exercise of skill, research knowledge, planning and ingenuity. He is seldom aware that these same attributes combine to bring his food to him clean, sound, wholesome and nutritious, with their fresh qualities, flavor characteristics and eye-appealing properties substantially conserved. He little appreciates what has been involved to preserve food for him, to provide variety, independent of the seasons, and to hedge against short supplies. He takes for granted the convenience of preparation and serving that is being built into more and more food products in order that they may fit into the pattern of modern living.

From the days of Nicholas Appert, who established the principles of the canning process and the researches of Louis Pasteur which are basic to so many food processes, Food Technology through research, together with the great progress made in the fields of transportation and refrigeration, has pushed back the frontiers of knowledge to make new applications so that foods of increasingly better quality and in greater array are being made available.

In the fields of food processing and distribution, developments are coming along so rapidly and are so competitive and complex that increasingly great sums are being invested in research and product development so that technical advances may continue and so that the food industry's responsibility to the public may be discharged. Such circumstances, human nature being what it is, make essential the establishment of controls over an industry as large as the food industry.

The Pure Food Law and the Meat Inspection Act established fifty years ago are milestones of human progress and have contributed most significantly to the safety and wholesomeness of our food supply. They stand as monuments to the vision and efforts of Dr. Harvey W. Wiley and to President Theodore Roosevelt who, more than anyone else, must be regarded as the "father" of the Meat Inspection Act of 1906. They are linked with the progress that has been experienced in the production, processing and distribution of our food supply.

As president of the Institute of Food Technologists, it is my privilege to bring greetings from that organization on the occasion of this historic event and to pay honor to the pioneers who brought into being our food

(Continued on page 16)

[a] Presented before the National Meeting Commemorating the Fiftieth Anniversary of the Food and Drug Act, June 27, 1956, Washington, D. C.

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(Continued from page 14)

laws. To their successors is extended best wishes, in a spirit of cooperation and with recognition of the fact that Food Technologists and those administering our food laws have much in common.

As our knowledge of foods increases, we become aware of new problems which are also apt to become increasingly complicated and controversial. Because of such developments already, various forms of new legislation regulating foods have been proposed. Regarding them, I know some leading food scientists who favor solving controversial scientific problems pertaining to food, as they arise from time to time, by utilizing an Ad Hoc Scientific Advisory Committee to be appointed by the Secretary of Health, Education and Welfare, from nominees by the National Academy of Sciences—National Research Council, drawing on the resources that reside in such quarters as the scientific specialists in our universities and the Institute of Food Technologists. This feature is included in the Miller Pesticidal Amendment of 1954 and appears to be working well and is provided for in some of the bills pending. It is said that were such a provision embodied in any forthcoming chemical additives law, many current and future food problems could be solved satisfactorily and in the interests of the public.

At any rate, in connection with any revision of our food laws, let us not curtail scientific and technological progress in the field of food by unwise or ill-considered legislation.

FEATURING THIS MONTH . . .

Food Technology at Homebush (N.S.W.) Australia

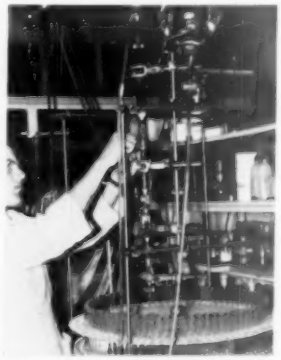
J. R. Vickery

Division of Food Preservation, Commonwealth Scientific and Industrial Research Organization

THE FOOD PRESERVATION RESEARCH LABORATORY at Homebush, N. S. W., is the headquarters of the Division of Food Preservation of the Australian Commonwealth Scientific and Industrial Research Organization. Branch laboratories are located at Brisbane, Queensland, Gosford, New South Wales, and Hobart, Tasmania. The Homebush laboratory with 34 research officers and a total staff of 115 people is by far the largest food research institution in Australia. While a considerable part of the work at Homebush has been devoted to long-range fundamental work in food chemistry, physics, microbiology and plant physiology, a wide range of applied research problems in the preservation and processing of meat, fish, eggs, fruits and vegetables has been studied. As Australia is a major food exporting country, sending much of her produce to markets as far distant as 13,000 miles, close attention has been given to reduction in wastage and improvements in quality. The annual value of Australia's exports of meat, eggs, fruits and vegetables alone, in various forms, now exceeds £60,000,000 per annum.

Homebush Laboratory, Senior Staff (l. to r.): E. G. Hall (in charge, fresh fruit investigations), F. E. Huelin (senior chemist), J. R. Vickery (Chief of the Division), W. J. Scott (senior bacteriologist), E. W. Hicks (senior physicist), L. J. Lynch (in charge, canning investigations).

While emphasis has usually been placed on problems in the export field, many applied investigations have been carried out on behalf of the industries catering for the home market of 9 million people. Some of the laboratory's achievements will now be outlined.



Homebush Laboratory. Use of ion-exchange resin columns in studies of the changes in stored foods.

EGGS

Up to the year 1945, serious losses due to bacterial rotting were experienced in shell eggs stored for local consumption or exported to the United Kingdom. While it had been known for many years that the washing of eggs increased wastage, there was no satisfactory explanation of the erratic incidence of spoilage in different packs of washed eggs.

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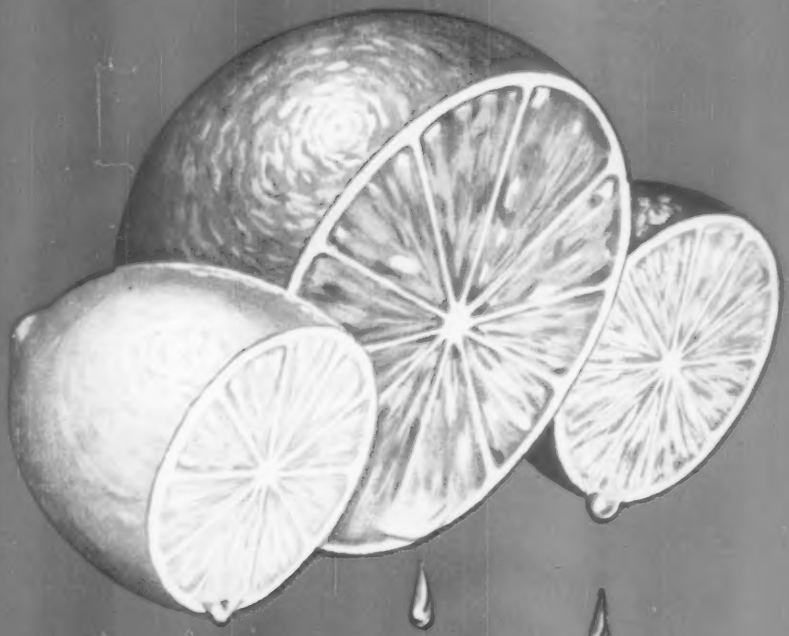

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(Continued from page 16)

The Homebush investigators clearly demonstrated that high incidence of wastage was associated with the use of certain types of washing machines widely used on farms. These machines were shown to be "reservoirs" of infection for several types of bacteria which cause spoilage. Only unwashed eggs are now accepted for storage and export, and wastage has diminished to negligible amounts.

The annual exports of frozen egg mélange now exceed 12,000 tons, and a fine reputation for high quality has been built up by the exporters. Samples for the determination of bacteriological quality of the mélange are regularly taken by inspectors. While the plate count method is used as a reference standard, it is time-consuming and gives an answer only after 2 or 3 days. The Division has devised a rapid test based on the reduction of the dye-stuff resazurin. This method yields results in about 8 hours or less and they correlate well with the standard plate-count method. The resazurin method is now universally used in Australia for the bacteriological grading of egg mélange.

APPLES

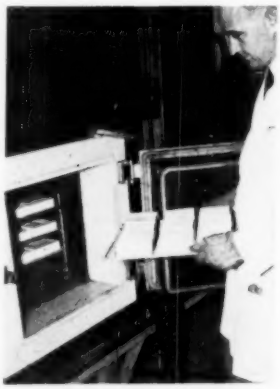
A high proportion of the Australian apple crop is either exported to European or South Asian markets or is cool stored for long periods for local consumption. Good keeping quality is therefore essential. It has been known for many years that small fruit keep better than large fruit and that apples from a heavy crop keep better than those from a light crop. The Division's fruit storage investigators showed clearly that the number of individual cells per fruit did not differ greatly from fruit to fruit, but that the larger fruit owed their size to larger cells. They found, too, that the larger the cell, the greater is the respiration rate per unit weight of protein in that cell. The more rapid ageing and greater susceptibility to disorders in light-crop fruit can therefore be related to the higher respiration per unit of cell protein. Attempts to raise the average size of apples without impairing keeping quality must therefore be concerned with increasing the number of cells, and at the same time keeping the cell size small. The problem has now passed from this laboratory to the horticultural scientist.

BANANAS

Cavendish bananas produced on the sub-tropical and tropical east coast of Australia are transported to distant centers as cut "fingers" packed in wooden cases. C.S.I.R.O. investigators have defined the precise temperature for the correct ripening of both summer and winter grown fruit, and also the required concentrations of the accelerator of ripening—usually ethylene. The conditions of correct handling and long-distance transport by rail (in ventilated cars) have been specified. Whereas, 20 years ago, wastage was heavy and the eating quality of the bananas was poor, today the general adoption of the Division's recommendations has resulted in negligible wastage and excellent quality fruit being available throughout the year.

PREDICTION OF MATURITY IN PEAS FOR PROCESSING

It has long been realized that quality of peas for canning and freezing is closely related to their maturity at harvest, but reliable methods for measuring and predicting maturity in the field have not been available.



Homebush Laboratory. Loading of experimental blast freezer with packets of peas.

In order to measure maturity, Homebush investigators devised a portable instrument, known as the Maturometer, which registers on a dial the force required to puncture a sample of 143 peas by a similar number of pins.

Tasting tests have shown that the maturity most acceptable to consumers lies between 11 and 16 percent alcohol-insoluble solids in the peas, this range corresponding to 210 to 375 units on the Maturometer scale.

The stage at which a crop will contain the greatest proportion of peas within the 210-375 units range was determined by sampling a large number of crops and subjecting the results to statistical analysis. It was found that the optimal harvest time corresponded closely to 250 Maturometer units. The data obtained in these tests have been used to evolve a simple method of predicting the optimal harvest day for particular crops. The rate at which a crop matures averages 20 units per day. If, therefore, the Maturometer unit value of the crop is determined by proper sampling methods, then the number of days required to reach 250 units may be readily estimated.

These methods of measuring and predicting maturity in pea crops are now being widely used in Australia. Not only is the processor now getting more uniform and better quality peas, but the grower is receiving better returns by not being penalized for excessive proportions of over-mature peas or lighter yields of under-mature peas.

HANDLING OF PRAWNS (SHRIMPS)

Large quantities of prawns (shrimps) are landed at east coast ports, and the majority are cooked at dockside processing plants before being transported long distances in iced cases to the main consuming centers. At the time of arrival at city markets, serious spoilage due to bacterial attack and to a condition known as "black-head" often occurred.

Research work has shown that bacterial spoilage can be eliminated by prompt cooling of the cooked prawns in bacteriologically clean water, followed by prompt icing and the adoption of sound hygienic precautions at all stages of handling.

(Continued on page 20)

They've just sampled the sausage with Huron **MSG**
. . . and voted it a solid 2 to 1 choice "'cause it tastes better"

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available in a full line of powders, pastes and liquids to add the mouth-watering richness of braised beef . . . at surprising economy

Proved Again: the unmatched ability of Huron MSG to awaken sleeping flavors. Fresh pork sausage packed by Chicago's Scott Petersen Company was taste-tested by 81 homemakers, lunching as a panel for the Home Arts Guild of Chicago. Each panel member was served a plate of sausages, half with Huron MSG added, the others untreated controls.

Results: better than a 2 to 1 vote for the MSG flavor-heightened sample. And preference for the sample with MSG jumped to a **rousing** 85% among the testers who serve pork sausage twice a week or more! Scott Petersen now uses Huron MSG, and is **successfully merchandising** this fact as an in-store sales-maker.

Huron MSG, "The Taste-Maker", does the same dependable job whether the pack is fresh, frozen or canned. Meat, poultry, seafoods, vegetables, packaged dinners . . . MSG intensifies your flavors to boost your sales. Call or write Huron today for Mono-Sodium Glutamate, 99+% Pure. And inquire about Huron's experienced, responsible technical service . . . it helps you make the very most of this wise decision.

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(Continued from page 18)

"Black-head" is caused by the development, through enzyme action, of a melanin-type pigment during some cooking operations. If the time occupied to heat the prawns through the temperature range 110° to 145° F. is excessive, either through over-loading the cooking

Commonwealth Official Photograph.

Dock-side prawn processing plant. Boiling of prawns in aluminum vessels prior to distribution.

vessels or through the use of water temperatures considerably below boiling point, then the enzyme system responsible for discoloration will not be inactivated rapidly, and "black-head" will occur. Appropriate cooking procedures have been defined and their wide application has virtually eliminated the disorder.

CONCLUSION

In these, and other investigations in progress in this laboratory, we have been greatly helped by the full co-operation by many organizations and individual companies. Processing facilities in many commercial plants have been placed at our disposal for large-scale experimental work, and the laboratory has received many substantial grants of money. Such spontaneous co-operation has greatly helped in the rapid application of the results of scientific research.

BOOKS . . .

TRACE ELEMENTS IN HUMAN AND ANIMAL NUTRITION. By E. J. Underwood. Academic Press Inc., New York, 1956. 430 pp.

I had not realized the paucity of books dealing with mineral elements until reading the preface of Dr. Underwood's book. As he points out, numerous books have been published on the vitamins but none dealing wholly with trace elements in human and animal nutrition. It is, therefore, fortunate that a complete book on this subject has been prepared by an author who has not only been an active experimental worker in this field but has had considerable experience in the broad world problems of mineral nutrition.

The first chapter introduces the reader to the trace element concept, the development of knowledge of the trace elements, the mode of action and trace element interactions. A complete chapter is devoted to each of the following elements: iron, copper, molybdenum, cobalt, nickel, zinc, manganese, iodine, fluorine and selenium. Aluminum, arsenic, barium, boron, bromine, silicon, strontium, and vanadium are discussed together. A most interesting chapter is included covering soil-plant-animal inter-relationships. Since there is much misinformation in this area, it is well to have authoritative statements regarding this problem.

This book is authoritative, up-to-date, concise and well documented. An excellent subject and author index is included. Anyone interested in nutrition and food technology will find this a most valuable and essential volume for his library.

C. A. ELVEHJEM
Madison, Wisconsin

DICTIONARY OF DIETETICS. By Rhoda Ellis. Philosophical Library, Inc., New York 16, New York. 152 pages.

The idea of this little book is good. It contains a comprehensive, alphabetical arrangement of terms and phrases related to food, food preparation and service, anatomy, physiology, chemistry, medicine, and diet therapy. In addition, there are included "capsule" identifications of a limited number of men of science who have pioneered in the field of nutrition. Several professional and scientific organizations whose efforts are devoted to dietetics and nutrition are also mentioned.

In many instances, however, terms are not actually defined. Instead, facts related to the subject are offered. These facts frequently have community, social, economic, and medical implications—interesting in themselves but not, in any real sense, definitive. Definitions include medical treatment. This appears to be beyond the scope of the book.

An effort is made throughout the book to evoke human interest. In so doing much emphasis has been placed on the caloric value of foods, infant feeding, geriatrics, and food fads and fallacies. Foods are defined in terms of their therapeutic values rather than their role in effecting normal nutrition. The rather frequent occurrence of inaccuracies, loose and incoherent statements, undefined abbreviations, and poor use of the English language detracts from the value of this book in the training of professional personnel. For the lay person, its use would be confusing. It is regrettable that three of the professional organizations mentioned are incorrectly named.

Since the idea of the book has merit, a thorough revision might salvage the effort that has undoubtedly been expended upon it.

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IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

NEW YORK . . . .

Color in Processed Foods Discussed by New York Section. Informative talks on the control of color, and its use in processed foods, highlighted the May 16 meeting of the New York Section of the Institute of Food Technologists.

Physical properties of color and instruments available for its measurement were detailed by the first speaker, Mr. F. L. Wurzburg, Jr., Color Coordinator, Interchemical Corp., N. Y. C. Then, Dr. R. C. Sherwood, President of the New York Section and Technical Director of Sterwin Chemicals, Inc., N. Y. C., reviewed the characteristics and uses of FD&C and natural colors as functional food additives.

Mr. Wurzburg noted that spectrophotometry is the basic tool by which permanent color standards can be set up and maintained. However, the instrument is still relatively costly and complex, and not always adaptable to control of day-to-day production. As a result, much work has been done on the development of a simpler instrument—the tristimulus colorimeter.

This unit attempts, through the use of color filters and photoelectric cells, to simulate the spectral responses of the three sets of nerves occurring in the normal human eye. The responses of these photocell-filter combinations to a colored stimulus, therefore, yield tristimulus values directly. Although colorimeters still have limitations, the speaker predicted that most of them would be overcome in time. Then, instruments will be available to provide convenient, quick, and accurate determination of tristimulus values at reasonable cost.

Turning to the use of food colors, Dr. Sherwood pointed out that the synthetics have come into prominence because of their stability, brilliance, and reproducibility. However, natural colors such as annato and beta-carotene (now synthesized) also find application in dairy products and fats. Mineral colors, on the other hand, are not much used.

The speaker discussed the chemistry and properties of FD&C colors, as well as the exacting procedure for their certification. A sample of each color batch is analyzed by FDA to see that it conforms to specifications. Mixtures of colors may be certified providing that they consist of previously certified colors and harmless diluents.

Although these materials offer the processor a convenient method of controlling the color uniformity of a product, they, of course, can not be used to conceal any inferiorities.

To demonstrate the versatility of FD&C colors, Dr. Sherwood showed slides of various color formulations that can be made to almost any desired shade. And for convenience of the processor, these blends are commercially available.

New Officers. Elected as officers of the New York Section for the 1956-1957 term were:

President: Dr. J. C. Bauernfeind, Hoffman-LaRoche, Inc.

Vice President: H. A. Campbell, General Foods Co.

Secretary: R. R. Bien, Good Housekeeping Bureau.

Treasurer: A. Astrack, Pak Research Associates.

Regional Section Councilors—for 2 years: Drs. J. C. Bauernfeind, A. A. Schaal, R. C. Sherwood.

Directors—for 3 years: N. H. Ishler, D. H. Warren.

PERSONNEL

Lloyd A. Hall, Technical Director, The Griffith Laboratories, Inc., has been named as the recipient of the 1956 Honor Scroll Award of the Chicago Chapter, American Institute of Chemists. Dr. Hall, a past Chairman of the Chapter, was chosen "because of his intense interest and influence in promoting truly professional attitudes and constructive actions in the profession of chemistry, his enthusiasm and positive direction in guiding and promoting the professional growth of young chemists, his very active participation and recognized leadership in both civic and technical organizations, and because of his outstanding technological accomplishments in industry." The Honor Scroll will be presented to Dr. Hall at a Testimonial Award Banquet in Chicago on October 5, 1956.

PHI TAU SIGMA HOLDS SECOND ANNUAL MEETING — NEW OFFICERS INSTALLED

Phi Tau Sigma, the honor society for food science, held its second annual meeting on June 12 in the Sheraton-Jefferson hotel in St. Louis, Missouri, site of the Sixteenth Annual Meeting of IFT. The meeting was highlighted by the installation of the national officers for the coming year. They are: Dr. Carl S. Pederson of Cornell University, President; Dr. Emil N. Mrak of the University of California, Vice-president; Dr. Edward E. Anderson of the University of Massachusetts, Secretary-Treasurer. Dr. F. J. Francis of the University of Massachusetts is serving as Executive-Secretary for the second year of a three year appointment. These posts had been held for the previous year by Dr. William B. Esselen of the University of Massachusetts, Dr. C. S. Pederson of Cornell University and Dr. Jean F. Caul of Arthur D. Little & Co.

Dr. Walter A. Maclinn announced that Mr. Lee J. Kenyon of the Preservalline Co., Flemington, New Jersey had donated five hundred dollars to be used for an annual award of one hundred dollars for a Phi Tau Sigma student member in recognition of outstanding achievement in food science.

The aims of Phi Tau Sigma are to encourage the development of food science, to honor notable accomplishments in the field, and to promote professional fellowship.

(Continued on page 24)

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(Continued from page 22)

MASTERS AND DOCTORS IN FOOD TECHNOLOGY AND RELATED SUBJECTS—1956

Problems related to the stability, the bacteriology, the nutritional quality, the economics and the packaging of specific commodities have been investigated by graduate students in food technology and related fields during 1956. Color continues to be the object of much research interest—both in regard to pigment formation and pigment changes. The chemistry of flavor is another topic which has attracted advanced study. The new treatments—radiation and antibiotic preservation—are represented. The economic and legal aspects of the food business come in for some attention—a somewhat new field of inquiry in food studies.

Reading between the lines—or perhaps one should say between the titles of the theses and dissertations herewith listed—it is evident that new tools and techniques are playing an ever-increasing role in the food sciences. Physical, chemical, histological and many other phenomena are being elucidated by the newer methodology, and the graduates now coming out of the colleges should be able to contribute in substantial degree to the forward rate of progress in food technology and science.

As previously, the list is alphabetized according to institutions and, within an institution, according to the names of the degree winners.

UNIVERSITY OF CALIFORNIA AT BERKELEY

Name	*Degree*	*Title of Thesis*
Hendel, Carl E.	Ph.D.	Browning Rates and Equilibrium Vapor Pressures of White Potatoes in Later Stages of Dehydration
Jacoby, David	M.S.	Water Absorption by Dry Beans
Peterson, Richard G.	M.S.	Pigment Formation in Onion Tissue Macerates
Zuegg, Enrico	M.S.	Peroxidase Assay in Vegetable Tissue by Ascorbic Acid Oxidation Procedures

UNIVERSITY OF CALIFORNIA AT DAVIS

Benjamin, McDonald P.	M.S.	Storage Stability of Heat Processed Orange Juice Concentrate
Conroy, Albert	M.S.	The Freeze-Drying and Subsequent Storage of Animal Products
Knapp, Frederick W.	M.S.	Some Physical and Chemical Changes in Gamma Radiated Meats
Papakyriakopoulos, Vassilios	M.S.	Some Relationships of Quality and Composition in Port and California Cabernet Wines
Postlmayr, Harold L.	M.S.	Characterization of Pectin Changes in Clingstone and Freestone Peaches During Maturation and Processing

CORNELL UNIVERSITY, ITHACA, NEW YORK

Silver, Alan H.	M.S.	The Chromatographic Separation and Quantitative Measurement of Caffeic Acid and Chlorogenic Acids
Tonseth, Ernst I.	M.S.	A Study of the Effect of Salt Brine Concentration on Some of the Changes in Fish Muscle Proteins During Freezing under Different Storage Conditions

Name	*Degree*	*Title of Thesis*

UNIVERSITY OF GEORGIA AT ATHENS

Thompson, Edwin C.	M.S.	Spoilage of Canned Field Peas Related to Heat Penetration Rates and Spore Destruction Rates

UNIVERSITY OF MARYLAND AT COLLEGE PARK

Kornetsky, Aaron	Ph.D.	A Quality Control Program for the Processing of Sweet Corn

UNIVERSITY OF ILLINOIS AT URBANA

Cary, Larry L.	M.S.	Studies on Packaged Comminuted Meats
Johnson, Ogden C.	Ph.D.	Chemical and Nutritive Changes in Thermally Oxidized Edible Fats and Oils
Johnston, Patricia	M.S.	No thesis
Litchfield, John H.	Ph.D.	The Oxidative Metabolism of Glucose by Rhodotorula gracilis
Murthy, Gopala K.	Ph.D.	A Comparison of Some of the Chemical and Physical Properties of Gamma Casein and Immune Globulins of Milk
Newman, Howard A. I.	M.S.	No thesis
Thorp, Richard C.	M.S.	Effects of Operational Variables on Freezing of Packaged Sweet Corn in an Experimental Air Blast Freezer
Touba, Ali	Ph.D.	Studies on the Sporulation Requirements of *Bacillus coagulans* Var. *thermoacidurans* in Synthetic Media
Vetter, James L.	M.S.	The Development of a Procedure for the High Temperature-Short Time Sterilization of Vegetables
Wollermann, Louis A.	Ph.D.	Analysis of Vanilla and Related Flavoring Materials

IOWA STATE COLLEGE AT AMES

Fortney, Cecil G.	Ph.D.	Milk Serum Equilibria as Shown by Dialysis, Ultra Filtration and Ultra Centrifugation I.
Lauck, Robert M.	M.S.	Some Properties of the Cathepsins of Bovine Muscle
Pirko, Paul C.	M.S.	Pigment Changes in Packaged Beef During Storage
Sullivan, Margaret J.	M.S.	Interior Quality, Flavor and Functional Properties of Untreated, of Oiled, and of Thermostabilized Shell Eggs
Ward, Charles B. Jr.	Ph.D.	Fungicidal Effect of Triethylene Glycol Vapor on *Penicillium notatum* spores

MASSACHUSETTS INSTITUTE OF TECHNOLOGY AT CAMBRIDGE

Bierman, George W.	Ph.D.	A Study of Effects of Ionizing Radiations on Milk
Bulakul, Niramol	S.M.	Relation of Lysine to Experimental Dental Caries
Burress, Donald A.	S.M.	The Effect of Oxalates on Calcium Metabolism
Del Valle, Francisco R.	S.M.	A Study of Citric Acid Production with Irradiated Culture of *A. Niger*
Freedman, Charles T.	S.M.	Laboratory Scale Investigation of Air Filtration

(Continued on page 40 following technical papers)

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In ice cream, stick novelties, sherbets, low fat and other specialties, FRODEX enhances flavor, makes texture smoother, raises initial freezing temperatures and increases tolerance to heat shock, builds total food solids content and improves meltdown. Used by a majority of manufacturers for over two decades.

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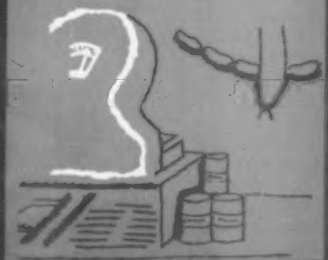

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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

Mass spectrometric analysis. Broad applicability to chemical research.

McLafferty, F. W. (Dow Chem. Co., Midland, Mich.). *Anal. Chem., 28* (3), 306-16 (1956).

The heated-inlet mass spectrometer, applied in the past mainly to petr. compds., is an analytical tool of broad applicability to the whole field of chemistry. Quantitative analysis approaching the high accuracy and no. of components found previously with light hydrocarbons is possible. Positive identification of unknown components of complex mixts. is illustrated. Unique information on mol. structure is provided, and complete structure detn. is often possible without standards.

Chelating agents in nonaqueous titrimetry.

Brummet, B. D., and Hollweg, R. M. (Edison Lab., Thomas Edison, Inc., West Orange, N. J.). *Anal. Chem., 28* (4), 448-50 (1956).

A nonaq. titrimetric procedure using chelating agents was developed for detg. metal ions. The procedure was applied to Ni, Co, and Cu, with accuracy and precision comparable to those of a strong acid-strong base titration. The use of nonaq. solvents for chelate titrimetry broadens the field in the same manner as it has broadened the scope of titration of other acids and bases. It opens a new phase of chelate titrimetry which may increase its specificity. By proper choice of chelating agent and solvent it is conceivable that titrations specific for many metal ions or groups of ions may be developed. Analysis by this procedure is rapid and does not require expensive equipment.

Review of fundamental developments in analysis.

Anal. Chem., 28 (4), 559-782 (1956).

Those reviewed are: light absorption spectrometry, infrared spectroscopy, ultraviolet spectrophotometry, x-ray absorption and emission, x-ray diffraction, Raman spectroscopy, electron microscopy, mass spectrometry, emission spectroscopy, fluorometric analysis, polarographic theory, instrumentation, and methodology, organic polarography, instrumentation, electroanalysis, amperometric titrations, potentiometric titrations, acid-base titrations in nonaqueous solvents, chromatography and electrochromatrography, inorganic gravimetric and volumetric analysis, volumetric and gravimetric analytical methods for organic compounds, biochemical analysis, distillation analysis, extraction, ion exchange nucleonics, inorganic microchemistry, organic microchemistry, statistical methods in chemistry, characterization of organic compounds.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Studies on the amino acid and vitamin composition of feather meal.

Gregory, B. R., Wilder, O. H. M., and Ostby, P. C. (Div. Animal Feeds, Am. Meat Inst. Foundation, Univ. of Chicago, Ill.). *Poultry Sci., 35* (1), 234-5 (1956).

The amino acid and vitamin contents of feather meal are given. These data indicate that the amino acids in feather protein are relatively stable during steam pressure processing in the production of feather meal, with the exception of arginine, phenylalanine, isoleucine and cystine. Of these, the only one showing considerable loss was cystine.

Modified milk-clotting procedure for determination of papain activity.

Gawron, O., and Draus, F. (Dept. of Chem., Duquesne Univ., Pittsburgh, Pa.). *J. Food Agr. Chem., 4*, 349-52 (1956).

A modified milk-clotting procedure, using cysteine as the activator, gives a linear relationship between inverse time of clotting and enzyme concn. over a 15-fold range of enzyme concn. $(NH_4)_2SO_4$ and NaCl inhibit enzyme activity and detn. of activity in their presence necessitates use of correction factors. The method is rapid and precise (2%) and suitable for routine detns. of enzyme activity in both absence and presence of inhibitor salts.

Methionine content of soybeans as influenced by location and season.

Krober, O. A. (Field Crops Res. Branch (USDA), Urbana, Ill.). *J. Agr. Food Chem., 4* (3), 254-7 (1956).

Methionine content of protein differs with soybean varieties. Some seasonal variations were also noted. It is concluded that soybean protein is produced in the seed with variable proportions of amino acids.

Interaction product of glycine and dextrose toxic to Phytophthora fragariae.

McKeen, W. E. (Plant Pathol. Lab., Univ. British Columbia, Vancouver). *Science, 123*, 509 (1956).

Compounds formed in the browning reaction, occurring between various amino acids and reducing sugars when autoclaving growth media, inhibit the growth of certain organisms. The inhibition cannot be traced to the unavailability of growth substances and the browning reaction products are therefore toxic per se.

BOTANY

Studies in plant metabolism. VI. Effect of 2,4-d on the metabolism of aspartic acid and glutamic acid in the bean plant.

Akers, T. J., and Fang, S. C. (Dept. of Chem., Oregon State Coll., Corvallis). *Plant Physiol., 31* (1), 34-7 (1956).

While the rate of photosynthesis in bean plants is markedly reduced by 2,4-D treatment, the incorporation of C^{14} from $C^{14}O_2$ in aspartic and glutamic acids is increased 3-4 times. However, the total amts. of aspartic and glutamic acids are decreased.

MICROBIOLOGY

Studies on the inhibition of growth of Escherichia coli by normal aminobutyric acids.

Friedman, S. (Dept. Bacteriol., Beth Israel Hosp., N. Y.). *J. Bacteriol., 71* (3), 278-84 (1956).

The influence of normal butyric acids with an amino group on either the α, β, γ, or ω, γ, positions on the growth of *Escherichia coli* and several auxotrophs in salts-glucose media was studied. In contrast to γ-aminobutyric acid, the remainder were inhibitory. The general significance of these inhibitions are discussed in terms of the sites blocked and the specific or nonspecific loci at which they may be relieved.

Persistence of individual strains of Escherichia coli in man and dog under varying conditions.

Sears, H. J., Janes, H., Saloun, R., Brownlee, I., and Lamoreaux, L. F. (Dept. Bacteriol., Univ. of Oregon Med. Sch., Portland). *J. Bacteriol., 71* (3), 370-2 (1956).

The fecal *Escherichia coli* strain compn. of 2 people subject to frequent diarrheic attacks were studied for more than a year and found to differ in no important respect from that of normal individuals. They showed neither more frequent changes of resident strain nor more numerous transients than normal subjects. One must conclude that frequent clearing of the bowel plays little or no role in bringing about these changes. Caged dogs, in spite of the fact that their eating habits undoubtedly cause them to ingest large numbers of *E. coli* of many strains daily, show the same general strain compn. pattern as human beings.

The effects of spray-drying on the viability of fungus spores.

Mazur, P., and Weston, W. H. (Biol. Lab., Harvard Univ., Cambridge). *J. Bacteriol., 71* (3), 257-66 (1956).

(Continued on page 28)

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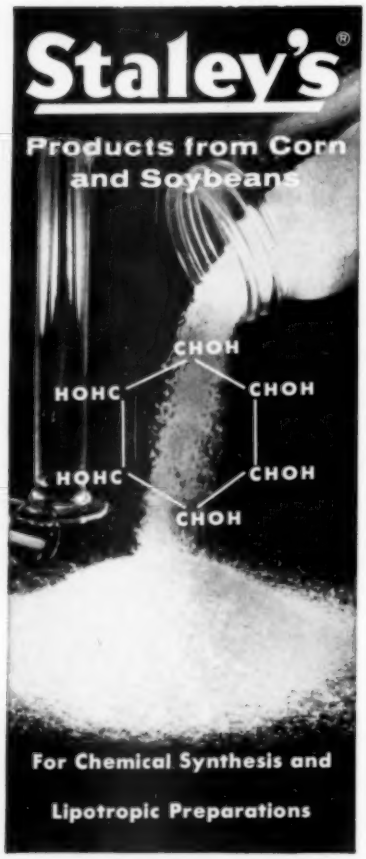

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(Continued from page 26)

The app. described was used to dehydrate horse serum suspensions of spores of *Aspergillus flavus* and *Pestalotia palmarum*. More than 80% of the spores were found to survive the initial spraying and more than 65% were viable even when the dried powder in the trap tubes was exposed to heated air for lengths of time up to 30 min. Other data show that fewer than 10% of the spores of *A. flavus* were killed by spray drying irrespective of whether the temp. in the drying chamber was 43°, 59° or 81° C.

NUTRITION

Experimental niacin deficiency.

GOLDSMITH, G. A. (Tulane Univ. Sch. of Med., New Orleans). *J. Am. Dietet. Assoc., 32* (4), 312-16 (1956).

Essentially all of the characteristic manifestations of pellagra were induced in human subjects given diets low in niacin and tryptophan. Pellagra appears to be a deficiency disease due to lack of niacin or its precursor tryptophan, and not to multiple deficiency of B-complex vitamins. A relationship has been observed between the development of niacin deficiency and niacin intake/unit of body size and, also, niacin intake/1000 calories of diet. Minimal daily niacin requirements with diets low in tryptophan (3 mg./kg. body wt.) is greater than 0.1 mg. per kg. body wt.

Effect of choline, methionine and ethionine on fat absorption.

TIDWELL, H. C. (Dept. of Biochem., Univ. of Texas Southwestern Med. Sch., Dallas). *J. Nutr., 58* (4), 569-78 (1956).

The rate of fat absorption was found by two methods to be accelerated when fat was supplemented with choline. The supplements of prostignine and mecholyl used failed to affect the rate of fat absorption. Evidence indicated that the effect of choline on the absorptive process is not a cholinergic one, but the result of an increased production of lecithin. The significantly increased blood fat levels after the use of ethionine might be assocd. with its reported liberation of a considerable amt. of free methionine. This might account for the accelerated rate of fat absorption, if the latter were continuously available in suitable quantities for addnl. choline and phospholipid formation which may in some way aid the passage of the fat into the intestinal mucosa.

Non-caloric sweeteners and weight reduction.

MCCANN, M. B., TRULSON, M. F., AND STULB, S. C. (Harvard Sch. of Public Health, Peter Bent Brigham Hosp., Boston). *J. Am. Dietet. Assoc., 32* (4), 327-9 (1956).

Two hundred forty-seven obese individuals and 100 diabetic subjects were questioned about their use of non-caloric sweeteners and artificially sweetened foods. Forty-three percent of the obese subjects and 80% of the diabetics were using or had used these products. No significant difference was apparent when the wt. loss of the users and nonusers of these products was compared. No correlation was found between the length of time these products were used and wt. loss, nor was the degree of overwt. assocd. with the use of these products.

Relative importance of inactivity and overeating in the energy balance of obese high school girls.

JOHNSON, M. L., BURKE, B. S., AND MAYER, J. (Sch. of Home Econ., Univ. Washington, Seattle). *Am. J. Clin. Nutr., 4* (1), 37-44 (1956).

Two groups of 28 obese and nonobese high school girls of similar height, age, and grade were compared in regards to food intake and activity. Both groups were found to be relatively inactive, but the obese girls were significantly more so. On a statistical basis, inactivity was much more important than over-eating. In fact the obese group had the lower caloric intake.

Muscular dystrophy in aging rats.

BERG, B. N. (Dept. of Pathol., Coll. of Physicians and Surgeons, Columbia Univ., N. Y.). *J. Gerontol., 11* (2), 134-9 (1956).

Muscular dystrophy developed after 2 years of age in Sprague-Dawley rats fed a good stock diet and maintained under favorable conditions. Incidence of the disease increased with advancing age. The condition appeared earlier and with greater frequency in males than in females. The histologic changes in the muscles resembled those observed in exptl. vitamin E deficiency.

Relations between diet and atherosclerosis among a working population of different ethnic origins.

EPSTEIN, F. H., SIMPSON, R., AND BOAS, E. P. (Sidney Hillman Health Center, N. Y.). *Am. J. Clin. Nutr., 4* (1), 10-17 (1956).

Data on the caloric and fat intake of an unselected working population showed that fat intake was related to the frequency of aortic atherosclerosis in men but not in women. However, the data were insufficient to relate coronary artery disease and fat intake.

Amino acid balance in nutrition.

ELVEHJEM, C. A. (Graduate Sch., Univ. of Wisconsin, Madison). *J. Am. Dietet. Assoc., 32* (4), 305-8 (1956).

The author accentuates the fact that no excess protein is necessary in the diet, or harmful if in excess, if amino acids in diet are balanced and in readily available forms. Use of excess proteins which are incomplete may be more deleterious than beneficial. In contrast to the widely tolerated ranges of other nutrients, the toxic levels of many amino acids range from two to ten times the requirements.

Effect of adding carbohydrate to milk diet. I. Growth and body composition.

(Continued on page 30)

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(Continued from page 28)

SARETT, H. P., AND SNIPPER, L. P. (Mead Johnson Res. Labs., Evansville, Ind.). *J. Nutr., 58* (4), 529-42 (1956).

Data are presented indicating that good growth and nutritionally sound rats are obtained with a diet of powdered milk or of two-thirds powdered milk and one-third added carbohydrate (glucose, sucrose, dextrin or starch) when each of the diets is supplemented with vitamins and trace minerals. In 6-wk. studies animals on the powdered milk diet (24.4% protein) gained approx. the same wt. as those on the added carbohydrate diets (16.2% protein). The caloric intakes were not significantly different on the various diets. The concn. of lipid in the carcasses of the animals on diets with added carbohydrate was higher than that found in the animals on the powdered milk diet. The concn. of protein in the carcasses of the animals was about the same on all of the diets studied. A diet of one-third lactose and two-thirds powdered milk supports poor growth of rats due to its high lactose content.

What the homemaker knows about nutrition. III. Relation of knowledge to practice.

YOUNG, C. M., BERRESFORD, K., AND WALDNER, B. G. (Sch. of Nutr., Cornell Univ., Ithaca, N. Y.). *J. Am. Dietet. Assoc., 32* (4), 321-6 (1956).

Actual performance of the homemaker in feeding her family was considerably better than her theoretical knowledge of what to feed them. The food groups about which the homemakers knowledge was weakest were also those most poorly used: namely, citrus fruits, tomatoes, and cabbage; green leafy and yellow vegetables; milk, cheese, and ice cream. The level of educational attainment had a closer related adequate performance in family feeding than level of income.

Current practices in bread enrichment.

KULP, K., GOLOSINEC, O. C., SHANK, C. W., AND BRADLEY, W. B. (Am. Inst. of Baking, Chicago). *J. Am. Dietet. Assoc., 32* (4), 331-3 (1956).

255 samples of wrapped sliced white bread, labeled as enriched, were analyzed for thiamine, riboflavin, niacin, Ca, and Fe as well as moisture, ash, protein and lactose. The av. results for enrichment factors exceeded the min. levels required by federal standards and those currently used in food value tables by the following proportions: thiamine 8%, riboflavin by 19%, niacin by 11%, and Fe by 13%. Milk content was about 3.9% nonfat dry milk solids per 100 lbs. flour. Average Ca content was 415 mg./lb. of fresh bread. Values compared with those prior to 1941 analysis indicate a significant increase in use of fat and milk solids as well as increased vitamin and iron content.

Need for research on soybean oil meal. Part I.

MCKINNEY, L. L., AND COWAN, J. C. (Northern Util. Res. Branch, Agr. Res. Service, U.S.D.A., Peoria, Ill.). *Soybean Digest, 16* (6), 14-16 (1956).

It is suggested that max. nutritional value cannot be attained from soybean oil meal (SOM) until further research is undertaken on the following: (1) stability of thiamin in SOM, (2) unidentified growth factors in soybean protein, (3) role of the isoflavones in SOM, and (4) the effect of soybean saponins on inhibition of growth, development of bloat in ruminants, and the stimulation of lactation.

Food standards.

COUNCIL ON FOODS AND NUTRITION, A. M. A. *J. Am. Med. Assoc., 160* (17), 1471 (1956).

In accord with the Councils' announced purpose of formulating desirable nutritional standards for classes of foods, recommendations for citrus and tomato juices are listed for the guidance of the medical profession, industry, and other interested parties.

PHARMACOLOGY AND TOXICOLOGY

The fate of ingested polyoxyethylene (20) sorbitan monostearate in rats.

WICK, A. N., AND JOSEPH, L. (San Diego State Coll., Calif.). *Food Research, 21*, 250-3 (1956).

Oral administration of C^{14} labeled polyoxyethylene (20) sorbitan monostearate to rats showed that 6-10% of the polyol moiety is excreted in the urine and 2-7% recovered in the expired CO_2. The remainder of the polyol moiety was recovered in the feces. Negligible amts. of C^{14} were recovered in the lymph fluid indicating that the amt. of polyol moiety recovered in the feces had passed through the intestinal tract without absorption into the vascular system.

Analgetic property of vitamin K.

KUBOVIC, M., PRAZIC, M., AND ATANACKOVIC, D. (Inst. of Pharmacol. Univ. Skopje, Yugoslavia). *Proc. Soc. Exptl. Biol. Med., 90* (3), 660-2 (1955).

Vitamin K was shown to have a stronger thermoanalgetic effect than morphine. The effect is not due to the mobilization of the hormones of the suprarenal glands. In patients with inoperative carcinomas and sarcomas the analgetic property was such that morphine and barbituates could be withheld.

PHYSIOLOGY AND MEDICINE

Neutralizing antibody to viruses of poliomyelitis in sera of domestic animals.

BARTELL, P., AND KELIN, M. (Wyeth Inst. for Med. Res., Box 8299, Phila. 1, Pa.). *Proc. Soc. Exptl. Biol. Med., 90* (3), 597-601 (1955).

The sera of cows and steers were shown to possess specific antibodies against the virus of poliomyelitis. Sera of hogs, horses and chickens possess modest neutralizing activity against polio viruses, whereas that of dogs, cats, calves and lambs do not possess any neutralizing activity. Attempts to isolate a virus from the bovine species that might explain the origin of these antibodies were unsuccessful.

Metabolism and age.

SHOCK, N. W. *J. Chronic Dis., 2,* 687-703 (1955); *Geriatrics, 11* (3), 49A (1956).

The reduction in metabolism with age appears to be more the result of loss of body tissues and cells having relatively high O_2 consumption rates, than a reflection of reduced metabolic activity of the remaining cells.

Metabolism of sorbitol.

ADCOCK, L. H., AND GRAY, C. H. (Dept. Chem. Pathol., King's Coll. Hosp. Med. Sch., London). *Nature, 177,* 329-30 (1956).

Studies with C^{14}-labeled sorbitol showed it to be relatively completely metabolized to CO_2 in the normal and the diabetic subject. Expired CO_2 became highly radioactive 1 hr. after ingestion of the C^{14}-sorbitol and remained for a further 8 hrs. Only 10% of activity appeared in the urine and feces; whereas at least 70% and probably 90% of the activity administered could be accounted for in expired CO_2.

FOOD AND FOOD TECHNOLOGY

COFFEE AND TEA

Tea—its pharmacology.

KRANTZ, J. C. (Dept. of Pharmacol. Univ. of Maryland, Sch. of Med.). *Coffee & Tea Inds., 79* (4), 45 (1956).

This article concludes the presentation of papers on the medical aspects of tea given at the New York Academy of Sciences. Discussed here are (1) the physical properties of caffeine (2) the effect of caffeine on cerebral centers (3) the effect of caffeine on medullary centers (4) absorption, fat and excretion of caffeine (5) toxicity of caffeine and (6) the diuretic action of methylated xanthines.

FATS AND OILS

22nd annual review of the literature on fats, oils, and detergents. I.

PISKUR, M. M. (Swift and Co., Chicago 9, Ill.). *J. Am. Oil Chemists' Soc., 33* (5), 203-18 (1956).

The use of antioxidants in dairy products.

TRACY, P. H. (Dept. Food Technol., Univ. of Illinois, Urbana). *Ice Cream Trade J., 52* (4), 56+ (1956).

A discussion of fat oxidation and the antioxidants normally used to prevent it.

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FISH AND SEAFOOD

Meal for human consumption.

La Revue de la Conserve, 10, 56 (1955); *Food Manuf., 31* (4), 159 (1956).

A new French process of prepg. fishmeal for human consumption is based on a practical and economic method of completely eliminating oils and fats so as to permit the prepn., from fresh fish, of fishmeal devoid of its typical odor and flavor and, therefore, more suitable for human consumption. The fat contents are removed in 3 stages by means of acetone and alc. Fish paste is first dehydrated with acetone. This is followed by heat treatment with EtOH and finally by dehydration and extn. of lipoid substances. The solvents (acetone and alc.) are recovered through distn. and returned to the circuit. The fish oils and fats thus extd. can be utilized.

Incidence of fecal streptococci and coliform bacteria in frozen fish products.

Larkin, E. P., Litsky, W., and Fuller, J. E. (Dept. of Bacteriol. and Public Health, Univ. of Massachusetts, Amherst). *Am. J. Public Health, 46* (4), 464-8 (1956).

A comparison was made between the most probable number of coliform bacteria and fecal streptococci in frozen fish and fish products. The use of the fecal streptococci as test organisms is advocated for the bacteriological examn. of frozen fish products. The testing procedures for the isolation of the fecal streptococci are simpler and the results more significant than those of the coliform bacteria. Plate count procedures are not applicable to the examn. of frozen fish products. It is probable that breading procedures are responsible for the high incidence of fecal streptococci on some fish products.

MEAT AND FISH

Evaluation of amino acids in fish processed by various methods.

Proctor, B. E., and Lahiry, N. L. (Dept. Food Technol., Massachusetts Inst. Technol., Cambridge, Mass.). *Food Research, 21* (1), 91-2 (1956).

The amino acid content of shad and haddock did not vary significantly whether the fish was raw, dehydrated, or canned.

The microbiological determination of the essential amino acids in fish protein.

Lahiry, N. L., and Proctor, B. E. (Dept. of Food Technol., Massachusetts Inst. Technol., Cambridge, Mass.). *Food Research, 21* (1), 87-90 (1956).

Essential amino acids in 3 varieties of fish were found comparable to that of beef and other animal protein. Vegetable proteins are often deficient in lysine, tryptophan, and methionine. All 3 are at good levels in fish protein.

Freezing fish in alginate jelly.

Olsen, A. (Leonard Hill Ltd., 9 Eden St., London, N.W. 1). *World Fisheries Abstr., 7* (1), 29 (1956).

Critical review of the protan method of freezing fish in alginate jelly and discussion of recent improvements. Different types of jellies are used for freezing small herring and sardines for canning. Protan jelly protects shrimp and whale meat from dehydration and discoloration. Good results have also been obtained with mackerel fillets and lightly salted herring. The development of the protan method has been rapid in Norway so that 1,800 tons of fish were frozen in 1955 as compared to 1½ tons in 1953.

Recent developments in the freezing of fish at sea. II. The quality of sea-frozen cod.

Banks, A. (Torry Research Sta., Aberdeen, D. S. I. R., Food Investigation Org.). *Chemistry & Industry, 43,* 1360-2 (1955).

A study was made to det. the effect of various icing and freezing procedures on the quality of the final product, namely the thawed and in some cases the smoked fish. As a result of the study it seems advisable to ice the fresh fish for a period of no longer than 3 days before freezing; also, freezing immediately seems to result in deleterious effects due to the fact that the fish have not attained a state of *rigor mortis* and they subsequently go through a *rigor mortis* state when thawed.

POULTRY AND EGGS

An unidentified mineral required by the chick.

Menge, H., Lillie, R. J., Sizemore, J. R., and Denton, C. A. (Agr. Res. Service, USDA, Beltsville, Md.). *Poultry Sci., 35* (1), 244-5 (1956).

Both feather meal and feather meal ash exhibited a growth stimulation that was significant at the 1% level. Feather meal that had been ashed at 700° C. for 5 or more hrs. was as effective in promoting growth of chicks as was the original material. It is therefore apparent that the unidentified growth factor present in feather meal is inorg. in nature.

Effect of rations on the pH and microflora in selected regions of the intestinal tract of chickens.

Wiseman, R. W., Bushnell, O. A., and Rosenberg, M. M. (Grad. Sch., Univ. of Wisconsin, Madison). *Poultry Sci., 35* (1), 126-32 (1956).

The type of carbohydrate used in the ration did not influence the pH of selected regions of the intestinal tracts of chickens fed rations which contained either yellow corn meal or B-grade molasses as the chief source of carbohydrate. The type of ration did have an effect upon the bacterial population of the intestinal tract. A reduced flora smaller than that obtained from the control group, was observed in the pullets fed the ration contg. B-grade molasses. Also, a lower population of bacteria was recovered from the more acid regions of the intestinal tract.

PRESERVATION AND STERILIZATION

Studies on preservation of marine products by chemicals. III. Comparative test of bactericidal effect of nitrofuran derivatives and some preservatives.

Tetsumoto, S., Okitsu, T., and Fukuda, M. *Bull. Jap. Soc. Sci. Fish., 20,* 1099-1104 (1955) (Summary in English); *Food Sci. Abstr., 28* (1), No. 92 (1956).

The bactericidal effect of nitrofuran derivs. on several species of bacteria was compared with that of chemicals already used as food preservatives (butyl *p*-hydroxy benzoate, salicylic acid, boric acid). Nitrofuran derivs. were found to be more effective at low concns. Their application to fish and fish products is discussed.

SUGARS AND STARCHES

Microscopic examination of modified starches.

Schoch, T. J., and Maywald, E. C. (George M. Moffett Res. Labs., Corn Products Refining Co. Argo, Ill.). *Anal. Chem., 28* (3), 382-7 (1956).

Granule aggregation can be detected by examn. in H_2O and glycerol media. The compn. of starch blends can frequently be evaluated by granule counts in a haemacytometer. The species of a pregelatinized starch is detd. by destroying the gelatinized material with enzyme and examg. the ungelatinized residue. The Kofler microscope hot stage provides a simple and accurate measurement of gelatinization temp., particularly useful for studying the effects of various adjuncts on starch gelatinization. Chemical modification of granular starches progressively lowers the gelatinization temp., and the extent and uniformity of derivatization can be estd. by this means. Positively charged dyes—e.g., methylene blue-stain anionic products such as oxidized starches, phosphate esters, and carboxymethyl ethers. Cationic starches stain only with negatively charged dyes—e.g., light green SF. Intensity and uniformity of staining provide evidence of blended starches and nonuniform derivs.

SWEETENERS

Artificial sweeteners.

Council on Foods and Nutrition, A. M. A. *J. Am. Med. Assoc., 160,* 875 (1956).

Brief survey of development and use of artificial sweeteners for use as functional food additives together with summary of report issued by the National Research Council. It reviews available information concerning toxicity of sac-

(Continued on page 35)

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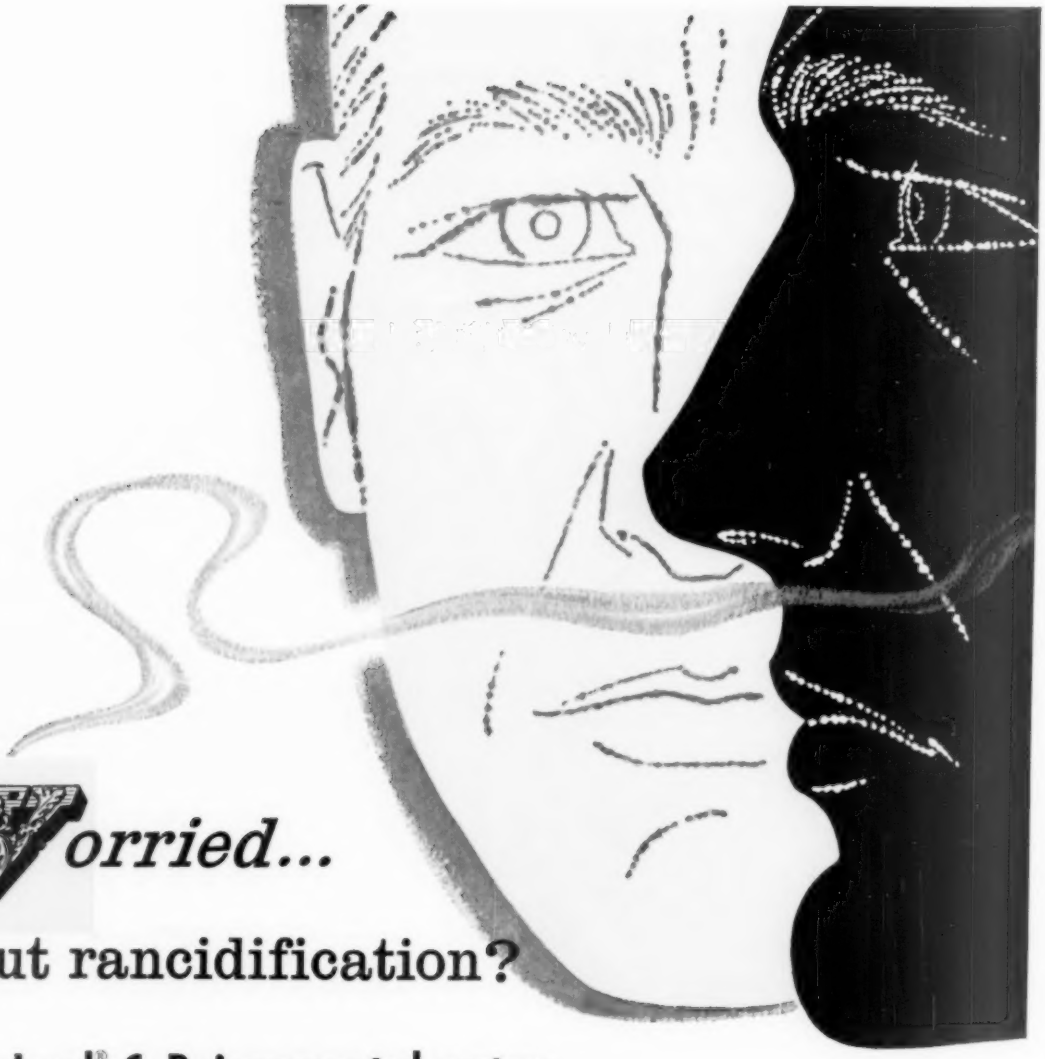

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Proposed Legislation Pertaining to Chemicals in Food*

A. L. Miller, M.D.
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MR. CHAIRMAN, HONORED GUESTS, LADIES AND GENTLEMEN: I feel honored to have the pleasure of appearing before this distinguished group of experts who deal with the problems of food chemistry and allied subjects. I pay my respects to you men and women who have made such a marvelous contribution to society through your efforts to improve the processing, the packaging, and the handling of food.

We who approach 3-score years in life have seen in our lifetime more advancement in science, in technology, and in the art of living than have people of any other equivalent period of history in this world. You and I have seen the coming of the automobile, the telephone, the radio, television, and a thousand and one gadgets that make life a little easier, and that give us more time to do the things we want to do in life. We have grown from the horse and buggy period to the jet-propelled plane that travels faster than the speed of sound. I doubt if the next 40 years will witness the many changes that have taken place in our lifetime.

One of the significant changes in the last three decades has been that of the scientific improvements in the dynamic and rapidly growing business of food technology. You scientists in your meetings today are dealing in research which has opened up new frontiers. Your findings have helped to create new industries, new and better jobs, and more and better things for a growing America. I believe the American standard of living is greatly benefited because of the new things that research has been able to accomplish.

Research is a process that involves basically no more than asking questions of nature and seeking the answers. What new promise will come tomorrow is still a secret to many of the chemists living today. There will always be horizons waiting for someone to explore and mysterious doors to future progress waiting for someone to unlock. It takes a pioneering spirit, a never-give-up attitude, to discover those horizons and to open those formidable doors.

There is no question that chemicals are needed in the preparation, preservation, and use of food. Much progress has been made through research in the field of nutrition and other practical applications of chemicals, and the American public can take pride in the manner in which our scientists and industry have handled these delicate problems.

THE DELANEY GROUP COMMITTEE

I was privileged to be a member of a Select Committee, known as the Delaney Group Committee, established in 1950. We held fifty-nine public hearings in 1950, 1951 and 1952, and heard 217 witnesses who presented their views; these witnesses were from the American Public Health Association, New York Academy of Medicine, National Research Council, United States Public Health Service, United States Food and Drug Administration, United States Department of Agriculture, Association of State and Territorial Health Officers, American Cancer Society, Grocery Manufacturers of America, National Canners Association, National Agricultural Chemicals Association, Manufacturing Chemists' Association, American Plant Food Council, General Federation of Women's Clubs, Cooperative League of the U. S. A., American Home Economics Association, National Council of Farmer Cooperatives, National Grange, National Farmers Union and others.

The Select Committee had this to say about food chemicals:

> The number of chemicals entering the food supply of the Nation has increased tremendously in the last decade. Chemical substances are being introduced into the production, processing, storage, packaging and distribution of food at an ever-increasing rate. There is hardly a food sold in the market today which has not had some chemicals used *on* or *in* it at some stage in its production, processing, packaging, transportation, or storage. These foods include those eaten by every family, ranging from staples like bread to such luxury items as the maraschino cherry. Some eminent pharmacologists, toxicologists, physiologists, and nutritionists expressed the fear that many of the chemicals being added to food today have not been tested sufficiently to establish their non-toxicity and suitability for use in food. These scientists are not so much concerned with the acutely toxic compounds, whose harmfulness can readily be detected, as with those chemicals which may produce harmful effects only after being ingested for months or perhaps for years.

In this Congress, several bills have been introduced that deal with chemicals in foods, the so-called food additives. Most of them attempt to regulate through the Department of Health, Education and Welfare the quantitative and qualitative application of these additives. I know that unwise and excessive regulations, coupled with unwise and excessive administration, can do harm to any industry. We ought to create a favorable climate, tax-wise as well as health-wise, if we are to promote the best interest of our cause. American industry must be encouraged to produce more and better goods. They ought to be produced at continually lowering prices because technical progress has shown the way. All legislation dealing with the question of chemicals in food should point the way to better living conditions. If the standard of living is lowered, we are going in the wrong direction.

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It is recognized that present law does not provide adequate safeguards to guarantee a food supply absolutely free of injury to the public health. The consuming public requires more protection.

Although industry has done a good job, we all know that in a tough economic world there is always someone ready to cut corners. That is why the public needs protection from those who might be less scrupulous than the large majority of the members of the food and chemical industry.

Chemicals, antibiotics, and other things that make food better are essential to many manufactured items. The proper use of chemicals and other methods of handling, preparing, and storing food has reduced the cost of food and has kept it at a higher quality.

It is my opinion that the horizons of tomorrow will show still further progress for the food and chemical industry. The scientists are uncovering the secrets of nature and helping us weave a new fabric of life that will be even more pleasant than the one we enjoy today.

CAREFUL HANDLING REQUIRED

The interest in food and drug administration is country wide. It is a subject that needs careful handling. We should not make the public hysterical. We should have composure and an objective view if we are to approach the problem in the interest of the public.

We should be sure that any new chemical is safe before permitting its application to the public food supply and that it will benefit the consumer. Now, by "benefit to the consumer" I do not believe this should be confined solely to a showing of functional value. We must recognize that foods with taste appeal, eye appeal, or sales appeal in many instances benefit the consumer just as they benefit the manufacturer and the dealer, to say nothing of the "ad man." It should be the responsibility of industry to thoroughly pretest the food additive before it is made available to the consumer.

We should never have a law which might permit untested chemicals to be introduced into food, but as the law now stands, they can be introduced into food, and the burden rests with enforcement agencies to determine whether or not they are injurious to the public health.

The bill that I have introduced sets up a panel or council which is advisory and may be used by the Food and Drug Administration or by industry when a dispute on a chemical arises. A panel will be selected from the members of the Academy of Science. Let me emphasize that they are merely advisory. If industry is not satisfied it may then appeal to the courts who would then make an adjudication between the opposing parties. In the meantime the new chemical could not be introduced into the food until the final decision is made. The bill requires prompt action and eliminates long delays.

There is a great need to fill the gap which seems to exist in the present law which permits untested and inadequately tested chemicals to enter the food supply. This country is fortunate in that we have a high-class group of gentlemen dealing with chemicals and food problems, and so the problems are less frequent than might be supposed.

NO READY OR EASY ANSWERS

The number of bills that have been introduced which deal with this subject indicate the desirability of such legislation, and the varied approaches emphasize that there is no universal agreement on the method for dealing with the problem. It is a technical subject. It deals with technical, scientific problems for which there are no ready or easy answers. It is also a delicate problem, because in considering in this legislation the desirability of a mechanism for the protection of the public health, we must not lose sight of the overriding principle that free enterprise must be encouraged in its constant research for a better, a more attractive, a more abundant, and a safer food supply for the American public.

I introduced a bill for such purposes in this Congress. It defines "new food additives" as

> "any substance or treatment used, directly or indirectly, in or on food for the purpose of affecting the appearance, flavor, texture, or storage property of such food, or for the purpose of otherwise altering and quality or property of such food, which is not recognized among experts qualified by scientific training and experience to evaluate the safety of food, to be safe for use under the conditions of such use or intended use."

In other words, this definition confers jurisdiction on the Department of Health, Education and Welfare to apply the procedural sanctions of this bill to any substance or treatment used in or on food if, in the quantity and manner of use, the substance is not recognized as safe by qualified scientists.

There are many food additives now in use that are safe and are recognized as safe. There are many food additives now in use about which we have little scientific knowledge, but which have been used without any laboratory or practical evidence of hazard to the public health. It is my feeling that legislation requiring exhaustive laboratory analysis, pretesting and reporting of the old, recognized, safe additives would serve no useful purpose and would be unduly burdensome upon both industry and Government. They should come under the so-called Grandfather Clause provision. If, however, evidence—scientific evidence—should be developed in the laboratory or otherwise, that an additive in use presents a reasonable probability of injury to health, the industry marketing that additive should be made to examine and re-examine its data and subject this additive to the scrutiny of the Department under this law.

Most of the bills that have been introduced on this subject agree, at least in principle, with this statement of the objectives of such legislation and with the jurisdiction which should be conferred upon the Department of Health, Education and Welfare as its enforcement agency. The bills all quite uniformly agree that any industry proposing to market a substance that comes within the definition of a "new food additive" should submit a report of the scientific pretesting that has gone into development of the substance to the Department. The bills also are in material agreement on what the

report should contain, and they all agree that the Secretary of Health, Education and Welfare should have certain power over the use of chemicals and other added substances in our food supply.

PROGRESS OF AMERICAN INDUSTRY MUST NOT BE BLOCKED

The significant division in thinking appears in the procedures that are to be established. Here again, however, we all agree that the public health is paramount, and we all agree that the magnificent progress of American industry must not be blocked by an unwise delegation of power to a Government agency. The procedures established by these bills all have this purpose in mind.

We are dealing here with a problem that is primarily scientific, and secondarily legal. The problem of "what is safe for public health purposes" is essentially one within the knowledge of scientists who are qualified by training and experience to evaluate safety factors.

I believe the primary responsibility for evaluating the safety of new additives should fall upon an advisory committee, composed of scientists. Any industry proposing to market a new food additive, after submitting its report of pretesting to the Secretary, may request that an advisory committee be appointed to examine the report of pretesting, and, after completing its examination, to submit recommendations to the Secretary. It should be emphasized that the function of the committee is, as the name implies, advisory only and its recommendations are not binding, in law at least, upon the Secretary. It does give the applicant and the Secretary the benefit of the knowledge and the impartiality of a board of experts. Members of the committee should be selected by the National Academy of Science from diversified scientific fields, skilled in the subject matter of the particular additive referred. Their independent and impartial knowledge can act as a brake upon any inclination that might appear on the part of the Secretary to exercise arbitrary and unreasonable control over industry. It can also serve as an arbiter between industry and the Department if sharp differences develop. The Committee can be requested and consulted by the Secretary, just as it can by the applicant industry.

THE ADVISORY COMMITTEE DEVICE HAS PROVED ITSELF

The advisory committee device has proved itself well in another facet of the food field since the enactment of P. L. 518 of the 83rd Congress. That law, of course, deals with the use of pesticide chemicals. It established advisory committees to make recommendations to the Secretary on pesticide chemical tolerances. I have followed the same framework in writing the advisory committee into new food legislation.

To those who fear the use of the advisory committee and suggest that it would become a tool in the hands of a capricious Department, may I say that on the only occasion when an advisory committee has been consulted under P. L. 518, the Committee's recommendations were contrary to the opinion of the Secretary, but the Secretary subsequently followed the recommendations of the Committee.

The Secretary is given authority to write regulations that will define the use of a new food additive. If the applicant, or any party adversely affected wishes to protest the regulations, he may file objections thereto and proceed to public hearing in the Department. The Secretary will then proceed to issue an order pursuant to the findings at the hearing, and the applicant's recourse is to the Circuit Court of Appeals.

Again let me say I am honored to appear before this distinguished group. I trust that in your deliberation you will give some thought to not only the new legislation but the type of legislation that will be best suited to a growing, dynamic America—the type of legislation that will best protect the health of America and provide the incentive for continued research in food technology.

Methods of Presenting Raspberry and Strawberry Samples to the Hunter Color and Color-Difference Meter[a]

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THE HUNTER COLOR AND COLOR-DIFFEREFNCE METER has been used with food products to obtain instrumental color measurements which will correlate with a visual estimate of the color. Previous studies have been mainly with homogeneous tomato products but in many foods one is faced with the problem of obtaining a composite reading from a heterogeneous sample. This may be effected by suitable construction of the instrument or by a suitable method of sample presentation. An example of the instrumental approach of measuring the color of heterogeneous samples is illustrated by the Purdue Color-Ratio Meter *(1)*. This instrument, fitted with appropriate filters, measures the color of a large area of the sample by means of a number of photocells situated in a circle around the object. The instrument reading accounts for the response from all the cells.

To obtain color readings of heterogeneous foods with the Hunter instrument, computing the arithmetic mean of a series of readings is an obvious approach. How-

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ever, this is not a rapid method and is not suited to routine control work. The standard deviation of such readings may be large and in order to establish significant differences, the results have to be treated statistically.

Color variation in a sample may be overcome by converting the sample to a homogeneous form. Shah and Worthington *(6)* used this technique with the Hunter instrument in measuring the color of strawberries. Strawberries were blended in a Waring blender and deaerated before a color measurement was obtained. With this method there is a danger of destroying some of the physical characteristics of the sample in the process of homogenization.

A composite reading can also be obtained by rotating the sample above the measuring instrument. Francis *(2)* used this method to measure the skin color of apples with the Hunter instrument and the Photovolt Meter. Kethley and co-workers *(3)* in measuring the color of beans, rotated the sample in front of the reflection attachment of a Beckman spectrophotometer. Sidwell and Cain *(7)* described an attachment to use with the Hunter instrument for obtaining readings from a rotated sample.

In this study the color of fresh and frozen raspberries and strawberries was measured by (a) computing the arithmetic mean of a series of readings, hence referred to as "spot readings," (b) rotating the sample, and (c) blending the sample before measuring the color with the Hunter Color Meter. The readings from rotation and readings from blending were correlated with the means of the spot values and the means of the spot readings in turn compared with the U. S. Department of Agriculture, Agricultural Marketing Service (Hereafter abbreviated as A.M.S.) scores for color.

MATERIALS AND METHODS

The 24 strawberry selections and 34 raspberry selections used resulted in a wide color range for each fruit. Hunter color measurements of mature fruits were obtained for each selection at several dates of harvest. A total of 47 strawberry and 106 raspberry samples were used.

Color measurements of fresh berries. A 10 to 12 oz. sample of whole raspberries or sliced strawberries was used to obtain the color measurement. The Hunter "L" scale was used for all color measurements and the instrument was standardized against the National Bureau of Standards red porcelain tile SKC 70 having the following "L" scale values: "L", 27; "a_L", 48.8; and "b_L", 16.4. The area of the sample illuminated was approximately 2¼ x 1½ inches. Three methods of presenting the same sample to the instrument were used and were designated as:

1. Spot reading
2. Reading from rotation
3. Reading from blending

Spot readings were obtained by presenting the sample to the instrument in a clear, rigid polystyrene container 6 in. in diameter and 1¼ in. deep. A series of readings were obtained at five different positions on the container. The means and standard deviations of these readings were computed.

The reading from rotation was obtained using the spinning attachment described by Sidwell and Cain *(7)*. The arrangement of the Hunter instrument with the spinning attachment is shown in Plate 1. The sample was rotated above the window of the instrument at a rate (80-100 r.p.m.) sufficient to give a steady galvanometer reading. The container was rotated "off-center" to present as large an area of the sample as possible.

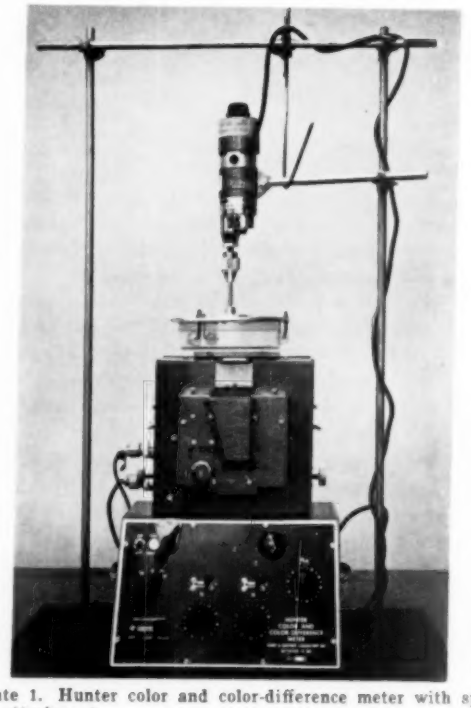

Plate 1. Hunter color and color-difference meter with spinning attachment.

The distance between the container and the instrument window was kept as small as possible and was of the order of ⅛ in. Francis *(2)* observed that if the sample was rotated within ½ in. of the Hunter instrument slight variations in the distance from the window were not critical.

The method described by Shah and Worthington *(6)* was used to obtain the reading from blending. The sample was blended for 30 sec. in a Waring blender and deaerated for 15 min. before presentation to the instrument. One observation of the three Hunter components was obtained.

Processing. The berries were washed, trimmed and packed in 301 x 411 "F" enameled cans. The strawberries were sliced and packed in the ratio of 4 + 1 (fruit + dry sugar). The raspberries were packaged using 10 oz. of berries and 6 oz. of 40% syrup. All cans were vacuum sealed and frozen at −20° F. (−28.9° C.) and stored at −5° F. (−20.6° C.) for one month before color measurements were made on the frozen berries.

Color measurements of frozen berries. The same three methods of presenting the sample to the instrument as used with the fresh berries were used with the frozen berries. The fruit was thawed for several hours before the color measurements were made. When measurements from rotation were obtained, it was necessary to use low rates of rotation due to the increased amount of liquid in the sample. This applied particularly to frozen raspberries. In some cases it was necessary to compromise between obtaining a steady galvanometer reading and spinning the sample at a rate which did not result in any major centrifugal effect on the sample. The blended sample was prepared from the berries and syrup.

Subjective evaluation of color. Since blending destroyed the physical characteristics of the sample, it was not possible to submit the identical sample to the A.M.S. grader. Therefore, a duplicate sample of the frozen berries from each date of harvest on which objective color measurements were made was graded for color by a professional A.M.S. grader. All samples were coded to eliminate any personal bias on the part of the grader.

RESULTS AND DISCUSSION

Standard deviations of the spot readings were calculated for each set of readings and the mean values of

TABLE 1

Mean standard deviation of spot readings for fresh and frozen raspberries and strawberries

	Mean standard deviation					
	Strawberries			Raspberries		
Hunter value	L	a_L	b_L	L	a_L	b_L
Fresh	2.24	2.09	1.62	1.12	1.71	0.67
Frozen	1.15	1.45	0.69	1.46	1.94	0.68

these deviations are tabulated in Table 1. In samples of fresh, sliced strawberries the variation within a sample was considerable, probably due to the white centers of some of the selections used. The frozen strawberries showed less variation. The mean of the five spot readings was taken as a reliable estimate of the overall color of the sample and the values obtained from the other methods of sample presentation were compared to these values.

The effect of variation in the rate of rotation on the Hunter values for a sample of fresh raspberries is shown in Table 2. Most marked effect was the change

TABLE 2

Variation in Hunter values with change in rate of rotation of raspberries

Rate r.p.m.	Hunter values		
	L	a_L	b_L
140	15.1	17.3	5.8
112	14.9	17.6	5.9
83	14.3	17.8	5.6
75	14.0	17.3	5.4
Spot Mean	14.7	17.4	5.6

in the Hunter "L" value. Increasing the rate of rotation resulted in an increase in the "L" value. The change in the Hunter "L" value as the rate of rotation was increased from 83 to 112 r.p.m. was small and any variation in this range would thus not result in a large deviation from the mean of the spot readings. Rate of rotation seemed to have little effect on the Hunter "a_L" and "b_L" values.

To obtain some indication of the rate of rotation necessary for a steady galvanometer reading, samples of fresh raspberries were rotated at a rate sufficient to give a steady galvanometer reading for each Hunter value. That the variation in a sample determines the rate of rotation necessary for a steady reading can be seen from Table 3. The rate needed for a steady galvanometer reading and the standard deviation of the corresponding spot values are tabulated. The optimum rate of rotation varied between Hunter values for the same standard deviation. It can be seen that a rate of 80-100 r.p.m. would be sufficient to give a steady reading in most cases. With reference to the standard deviations quoted in Table 1, except for fresh strawberries which are quite variable, a rate of 80 to 100 r.p.m. would suffice. A constant rate of rotation was not maintained throughout the whole experiment. The rate was adjusted to give a steady reading and was generally within the range 80 to 100 r.p.m.

The type of relationship obtained between the readings from rotation and the mean of the spot readings is shown in Figures 1 and 2. The means of 47 readings

TABLE 3

Rate of rotation of raspberries necessary for a steady galvanometer reading of Hunter values

	Rate needed r.p.m			Standard deviation of spot readings		
Hunter values	L	a_L	b_L	L	a_L	b_L
Sample 1	66	98	75	0.96	1.47	0.38
2	93	122	115	1.24	3.08	0.87
3	75	140	75	0.98	1.97	0.61

for strawberries and 106 readings for raspberries are given in Table 4. The agreement obtained between these two methods of sample presentation was particularly good especially when one takes into consideration the variation within samples. Highly significant correlations were obtained between the two types of readings.

There was a tendency for the Hunter "L" value, obtained by rotation, to be consistently lower than that of the corresponding mean of the spot values. As "a_L" and "b_L" are related to "L" one might expect a cor-

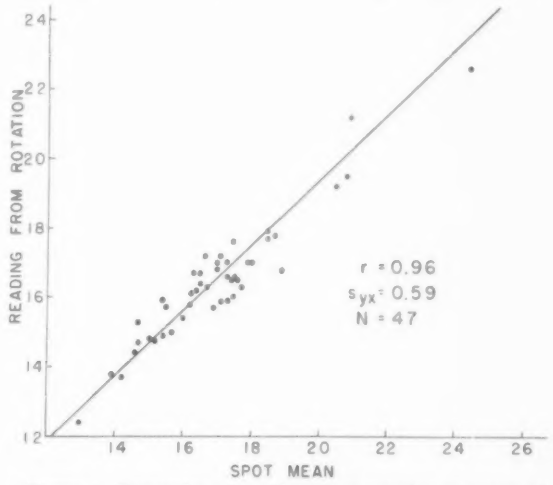

Figure 1. Regression of readings from rotation on means of "spot" values for Hunter "L" values of frozen strawberries.

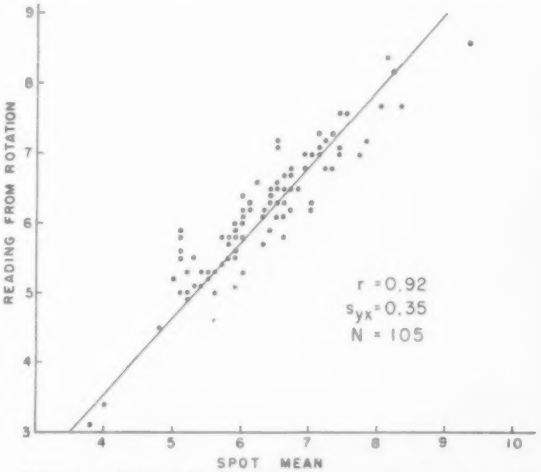

Figure 2. Regression of readings from rotation on means of "spot" values for Hunter "b_L" of frozen raspberries.

responding change in these values, but this was not observed. The decrease in the "L" value could be due to a decrease in the rate of rotation (Table 2). Frozen raspberries contained a considerable amount of liquid and consequently the rate of rotation had to be kept low enough to prevent centrifugal effects.

Mean values obtained from blending are given in Table 4. In all cases these were quite distinct from the corresponding means of the spot values. The blending procedure produced a homogeneous sample but also resulted in a different color from the intact sample. Hence, with blending, one does not measure the color of the fruit as a grader would observe it. The readings from blending correlated significantly with the means of the spot values, but the correlation coefficients were not as high as those obtained with readings from rotation.

TABLE 4
Mean values of reading from rotation, reading from blending and spot readings for fresh and frozen raspberries and strawberries

	Rotated			Blended			Spot		
Hunter values	L	a_L	b_L	L	a_L	b_L	L	a_L	b_L
Strawberries									
Fresh	24.3	28.5	13.3	21.5	24.2	10.4	25.2	28.3	13.3
Frozen	16.5	20.6	8.0	18.9	20.0	8.7	16.9	20.1	7.9
Raspberries									
Fresh	16.5	21.0	7.0	19.6	24.8	8.9	16.7	21.1	7.0
Frozen	14.5	18.7	6.2	19.0	20.8	8.4	15.1	18.4	6.3

Relationship between the color of fresh and frozen berries. These results afforded an opportunity for comparing the color of the fresh and frozen berries in a general way. The Hunter "L", "a_L" and "b_L" values specify the color of a particular sample, but the "L" value is the only absolute quantity of the three as the "a_L" and "b_L" values are dependent to a certain extent on the "L" value. The "L" value is a direct measure of lightness and is related to the Commission International de L'Eclairage (Hereafter abbreviated as C.I.E.) tristimulus value, "Y" by the equation:

$$Y = L^2/10{,}000$$

Hence, differences in the Hunter "L" value may be regarded as real differences, but it is not possible to attach any significance to changes in "a_L" and "b_L" values unless they are converted to some meaningful system of color notation. Changes in "a_L" and "b_L" could result from a change in the "L" value as well as a change in chromaticity. For comparison, the Hunter values were converted to the C.I.E. system and expressed as "% Y", "dominant wavelength" and "% purity." The Hunter "a_L" and "b_L" values are related to the tristimulus values by the equations

$$a_L = 175(1.02X - Y)/\sqrt{Y}$$
$$b_L = 70(Y - 0.847Z)/\sqrt{Y}$$

The Hunter values listed in Table 4 were converted to the C.I.E. system and are so listed in Table 5.

Definite changes in color were observed on comparing fresh and frozen berries (Table 5). The tendency for the blending procedure to minimize these differences was also quite marked. Frozen strawberries were much darker than fresh strawberries as indicted by the values for % Y in Table 5. There were also some variations in dominant wavelength and purity. The color of frozen raspberries was darker than that of fresh berries, but the change was small compared to that of strawberries.

TABLE 5
Color of fresh and frozen raspberry and strawberry samples expressed in C.I.E. notation

	% Y	Dominant wave length, mμ	% purity
Strawberries			
Spot			
Fresh	6.35	604	73
Frozen	2.86	610	66
Rotated			
Fresh	5.90	604	76
Frozen	2.72	610	68
Blended			
Fresh	4.62	607	67
Frozen	3.57	606	64
Raspberries			
Spot			
Fresh	2.79	616	60
Frozen	2.28	614	60
Rotated			
Fresh	2.72	616	60
Frozen	2.10	616	61
Blended			
Fresh	3.84	613	64
Frozen	3.61	609	62

Significant simple correlations were obtained between the color readings on the fresh and frozen raspberries and strawberries; however, the standard error of the regression was large and only an approximate estimate of the color of the frozen product could be obtained from that of the fresh product.

Relationship between color measurements and A.M.S. scores for color. For an instrumental measurement to be used for specifying color grades, it must first be compared to the present method of evaluating the grade. The original intention was to compare the values obtained from the three methods of sample presentation to the A.M.S. color scores and determine if any of the methods would correlate to a more significant level. No linear regressions were obtained which could be used to satisfactorily predict the color score of the sample with any of the methods of sample presentation used. The failure to obtain usable linear regressions in the region where the relation between instrumental and subjective values was approximately linear could be accounted for in the wide variation in A.M.S. scores. The comparison of a particular instrumental color value with the list of values obtained could give some indication of the color score.

Several factors are known to influence the degree of relationship between subjective and objective evaluation of color. Robinson *(5)*, working with tomatoes, commented that good correlations between instrumental and subjective color evaluations were obtained providing the colors did not cover too large a chromaticity range. The raspberry and strawberry samples used in this experiment covered a particularly wide chromaticity range. This may have accounted, in part, for the fact that the regressions between instrumental and subjective color evaluations were not satisfactory for prediction of the color score on the basis of the instrumental values.

It was also found that a straight line relationship, for instance, between Hunter "L" and A.M.S. color score was not a true representation of the situation. A straight line relationship may be valid only for a certain range. This point may be best illustrated by quoting examples of color scores and the instrumental values obtained. With frozen strawberries there was a tendency for the A.M.S. grader to score samples higher which had a higher "L" value, while the converse was observed with raspberries. In Table 6 the A.M.S. color scores and

TABLE 6
A.M.S. color scores and Hunter "L" values

	Strawberries		Raspberries	
	Hunter L	A.M.S. Grade	Hunter L	A.M.S. Grade
Sample 1	17.5	35	14.0	38
2	16.2	33	15.5	34
3	15.4	30	19.8	28
4	20.5	28	13.0	27

Hunter "L" values are tabulated for several samples of raspberries and strawberries. In each case the first three samples give an indication of the general trend observed. If a straight line relationship were obtained which fitted the trend indicated by the first three samples one would expect sample No. 4 to score high in both cases. The fact that both these samples scored low indicates that some critical value was obtained after which the score falls off rapidly with an increase or decrease in the Hunter "L" value as the case may be. Hence for the complete range of samples used a straight line relationship between Hunter "L" value and A.M.S. color score would not be a correct representation of the situation.

It would appear that in A.M.S. grading for color it is difficult to eliminate the effects of factors other than color. It seemed significant that the raspberry samples which received the highest scores for color were particularly free from broken berries. Providing a raspberry sample has a reasonably characteristic color, it may be that the general appearance of the sample will determine whether the sample will score high or low within a grade. This effect would also preclude an accurate correlation between instrumental and visual color measurements.

Mackinney and Chichester *(4)* have commented on the interrelation of purity and lightness in which the eye will accept as equivalent, specimens with different purities provided the lightness is suitably adjusted. This effect was clearly illustrated in this study where samples of higher % Y and low purity were scored equal to samples of lower % Y and higher purity. In view of the lightness and purity relationship it would be difficult to obtain a mathematical relationship between either of these attributes and A.M.S. color scores, particularly over a wide chromaticity range. If one restricted the samples to a smaller chromaticity range a working relationship may be obtained. This might be achieved by restricting the samples to one selection as large chromaticity differences were observed between different selections.

To obtain some information on the manner in which C.I.E. color factors influenced the A.M.S. color score, the means of the spot values for the frozen berries were converted to the C.I.E. system and compared with the A.M.S. scores. Only general trends could be obtained.

Higher "Y" value, up to a certain point, corresponding to a higher Hunter "L" value was generally consistent with a high score in strawberries (Table 6). Higher percentage purity also seemed to be associated with higher A.M.S. color scores. The range of dominant wavelength for strawberry samples was from 600 to 618 mμ with samples in the range of 606 to 610 mμ receiving higher scores, depending on the "% Y" and purity of the sample.

With raspberries a lower "L" value corresponded to higher scores for color. This was the most marked trend although there was some indication that a lower percent purity was also associated with higher A.M.S. scores for color. The dominant wavelength of the samples ranged from 606 to 624 mμ with most samples in the range of 612 to 618 mμ. In both cases the dominant wavelength or hue does not appear to be particularly critical, unless markedly displaced from the average values.

SUMMARY AND CONCLUSIONS

Three methods of sample presentation were used with the Hunter Color and Color-Difference Meter in measuring the color of fresh and frozen raspberries and strawberries. Measurements were made on 47 strawberry and 106 raspberry samples. Instrumental color values were compared directly and after conversion to the C.I.E. system with the A.M.S. grades for color.

A high correlation was observed between readings from rotation and the means of the spot values. In rotating the sample it was found that the rate of rotation necessary to obtain a steady instrument reading was dependent on the variation in the sample and the Hunter value in question. The rate of rotation affected the instrument readings to some extent; the smallest deviation from the mean of the spot readings was obtained with a rate of rotation of 80-100 r.p.m.

Readings obtained from blending were quite distinct from the corresponding means of the spot values; however, the values from blending correlated significantly with the latter. The differences observed between the color of the fresh and frozen berries were greatly reduced by blending.

In comparison with fresh strawberries the frozen product showed a marked reduction in lightness as well as a decrease in purity and dominant wavelength. The color of frozen raspberries showed only a small reduction in lightness and little change in dominant wavelength or purity when compared to the fresh product. Significant correlations were obtained between the Hunter values for the fresh and frozen berries. However, the standard error of the regressions was such that the color measurement of the fresh berries would give only an approximate prediction of the color of the processed product.

With raspberries and strawberries it was found that the color score increased fairly regularly with the appropriate increase in lightness up to a certain point. Any further change in lightness resulted in a rapid decline in the A.M.S. color score. The tendency for

the eye to confuse lightness and purity was illustrated by samples of low lightness and high purity being rated equal with samples of higher lightness and lower purity.

The dominant wavelength of raspberries and strawberries did not appear to be a critical factor. Providing the dominant wavelength fell in the average range the color score seemed to be associated more with lightness and purity. With frozen raspberries the general appearance of the sample affected the subjective evaluation of color.

It was not possible to obtain regressions between A.M.S. color scores and C.I.E. color factors which would serve to predict the color score from the instrumental values. The effects described in the preceding paragraphs would give rise to large errors in mathematical relationships between instrumental and subjective evaluations of color.

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A Recording Strain Gage Denture Tenderometer for Foods. III. Correlation with Subjective Tests And the Canco Tenderometer[a]

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(Manuscript received April 9, 1956)

Previous papers in this series *(5, 6)* have described various studies obtained with the strain gage denture tenderometer, including initial evaluation tests, changes in masticatory effects with variation in jaw motion and different teeth, and the force-penetration relationship. In this paper, the ability of the instrument to yield significant measurements on a particular food—namely, raw peas—is described.

The value of obtaining accurate measurements of the tenderness of raw peas is recognized by the food industry. The tenderness index of a crop of peas, as a significant indication of its time of harvesting, its yield, and its quality, is emphasized by the fact that it may serve as a basis for payment to the grower.

In the United States three primary methods exist which yield tenderness values with high degrees of significance. These are the subjective test, the alcohol-insoluble-solids test, and the Canco tenderometer. The latter instrument, because it requires considerably less labor and yields results more rapidly than the first two tests (with which it gives a high degree of correlation) has been adopted almost exclusively by the pea canners in their grading operations *(3, 4)*.

A distinct shortcoming of the Canco tenderometer is that it gives results indicative of only the average value of tenderness of a sample of peas. Uniformity of product, as affected by individual peas, is not measured. For example, the disproportionate lowering of quality by a small fraction of tough peas is not correctly evaluated *(2)*. Furthermore, satisfactory calibration of the Canco tenderometer has been difficult, leading to uncertainty in comparison of results arising from different instruments or even from the same instrument over a period of time.

The strain gage denture tenderometer has shown potentialities for correction of these difficulties by its ease in calibration and ability to measure individual peas with sensitivity and accuracy. The investigation reported herein has compared results with subjective tests and with the Canco Tenderometer in an attempt to determine the overall efficacy of the denture tenderometer in testing of peas.

APPARATUS

Masticatory properties of a food inserted into the denture tenderometer are objectively measured with the denture tenderometer which simulates the dental surfaces and chewing motions in the mouth. Measurements can be taken on reaction forces of food to teeth and penetration of teeth into food by means of electrical sensing elements. As in the mouth, this reaction force varies with the particular pair of teeth used, and with specific changes in the vertical, sideward, and front-to-rear motion of the mobile denture relative to the stationary one.

The instrument was equipped with modifications previously described *(5)*. For the tenderness measurements, force was the vertical deflection input and time was the horizontal deflection input. The vertical deflection on first bite was taken as the measure of tenderness.

The Canco Tenderometer. This instrument, used to a great extent in the quality evaluation of raw peas, was designed and developed by the American Can Company and is manufactured by Food Machinery and Chemical Coorporation *(3, 4)*. The standard model (Serial No. MM247) used was located at the Gerber Foods Company, Fremont, Michigan. In this instrument, peas are sheared between two grids, one of which is held stationary, the other moving at a constant rate. A pendulum mechanism measures the force involved and the machine is automatic in cleaning itself and stopping after each measurement.

[a] Contribution No. 295 from the Department of Food Technology, Massachusetts Institute of Technology.

SUBJECTIVE TESTS

Peas were used for subjective validation of the denture tenderometer as an example of a specific food. The peas used included the fresh, canned, and frozen forms. In some cases, they were treated in different ways in order to obtain a comprehensive scope of values for the subjective-objective comparisons. These treatments included storage at refrigerator temperature for periods of time up to three weeks, cooking for various periods of time up to 10 minutes, and partial drying for several hours at 85-90° F.

On each test day, the sample was prepared, divided into two equally sized portions and held at refrigerator temperatures of 36-40° F. Subjective and objective tests took place about one hour apart, with each series of tests requiring approximately one hour to perform. For each objective test, 72 peas of approximately equal size were used for readings.

Both the subjective and objective tests were performed on peas at temperatures of 36-40° F. For each day's tests, 24 members of the panel comprising staff and students of the Department of Food Technology, Massachusetts Institute of Technology, were used. Insofar as possible, the same personnel was used each day with the objective of making a large analytical type panel which could be considered a standard pea-measuring instrument. However, since it was not always possible to have the same people for each day's tests, the panel could not be considered truly analytical although it may be assumed to be a trained panel.

In order to increase the total number of evaluations, each panel member was given 3 samples, each containing 5 to 10 peas randomly selected from the prepared sample. The samples were separately coded, and the judges were told that the samples were not necessarily different. Biological variation of properties of individual peas in any given sample were evident, and the panel members were told to chew as many peas as they required to form an average opinion of score. The normal biological variations of individual peas were therefore included in the results, as they are in the objective tests.

Each panel member was instructed to rate the peas for tenderness (or toughness) on an 11-point hedonic scale numbered from 0 to 10, ignoring taste and aroma characteristics. The suggested criteria of points on the hedonic scale ranged from 10—*soft, like an olive* to 0—*hard, like a peanut*. Panel members were instructed to give scores above 10 or below 0 if necessary for correct evaluation.

The 0 and 10 standards of peanut and olive were chosen at the outset of the work so that judges would have anchor points for scoring and would not have to rely on memory which could lead to a sliding scale producing additional variations between individual members of the panel and between the same members on different days *(1)*. Therefore, each member of the panel was given, in each test, one salted peanut and one pickled olive, each taken from a freshly opened commercial pack of the same lot.

Although members of the panel were not instructed how to chew the peas, if they did request this information, they were told to perform their normal masticatory functions, using the molars. An informal poll at the conclusion of the tests indicated that this occurred in the majority of cases. Since each of the 24 panel members was given 3 samples and requested to mark three scores, a total of 72 scores were obtained for each sample lot.

Seventy-two peas of approximately equal size were randomly chosen from the same sample and tested with the denture tenderometer which was set at condylar, L = R = + 15 and lateral, L = R = 0. These settings produced motions regarded as reasonably close to those used in the chewing of peas.

COMPARISON WITH CANCO TENDEROMETER

Tests were conducted on freshly vined peas at the Gerber Foods Company, Fremont, Michigan, during the pea-canning season, for the comparison of measurements obtained from the Strain Gage Denture Tenderometer with those obtained from the Canco Tenderometer. The denture tenderometer apparatus was set up in the receiving area of the plant adjacent to the Canco instrument so that samples for the two instruments could be drawn from the same lot. Operators of the Canco instrument used a sample of about one half-pint size from each cart of vined peas entering the plant. A sample of 6 equally sized peas were chosen at random from the same lot for measurement on the denture tenderometer. Thus, 6 individual readings on the denture tenderometer were obtained for each corresponding average Canco readings. For purposes of statistical comparison, force readings from the Canco instrument were converted to a 10-point grade scale, where each grade, except grade one, represents 10 force units (grade one represents 0-100 force units).

RESULTS AND DISCUSSION

Correlation with subjective panel. Figure 1 shows the data obtained in the comparison tests of the denture tenderometer with a subjective panel. Each point

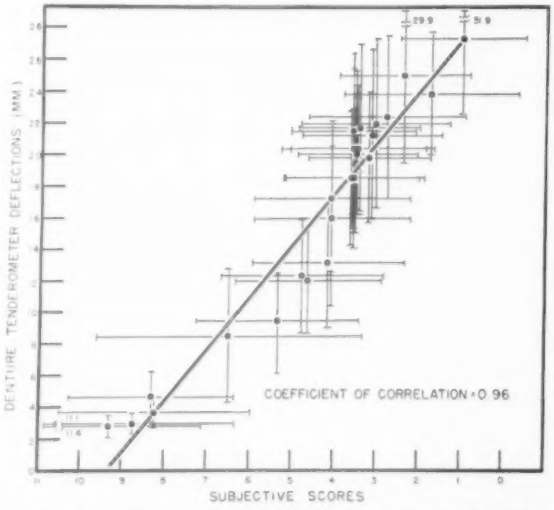

Figure 1. Curve showing correlation of denture tenderometer readings with subjective panel results.

shown represents the arithmetic mean value with the standard deviation of the mean given to indicate the dispersion of individual values around the mean. A good linear correlation is obtained; the coefficient of correlation is found to be 0.96.

Two main interpretations of these results may be made.

(a) Wth the exception of the points at the lower left-hand corner which represent cooked peas, the range limits of values about the mean obtained for a given sample do not differ greatly between the denture tenderometer and the subjective evaluations. A portion of the range of subjective values is possibly due to human error and not to intrinsic variations in the peas. The exact extent of this portion is not known, but evidently it does not greatly exceed the inherent pea variations when such variation is appreciable (as it apparently is for raw peas).

(b) In the case of the cooked peas, represented by the points in the lower left-hand corner, the variations in pea tenderness are very small, indicating that the denture tenderometer is unable to detect variations within samples of cooked peas. However, the ranges of subjective evaluations for the same peas are considerable in comparison, although the dispersions are of about the same magnitude as those found for raw peas.

Comparison of Denture Tenderometer with Canco Tenderometer. Figure 2 shows the data obtained in the comparison tests of the denture and Canco tenderometers. Each point shown represents the arithmetic means of an average of about 20 Canco readings and about 120 denture tenderometer readings. Standard deviations are given for each point on both coordinates to indicate the dispersion of individual values about the mean. This is done to indicate the spread of values obtained with both instruments, and is not an analysis of instrument precision. The latter can only be validly made when samples of known constant input are used. This has been done previously with the denture tenderometer *(6)*. A good linear correlation is obtained for the two instruments; the calculated coefficient of correlation is 0.99. Two significant features are evident from this experimental work *(6)*. There is a close correlation of the two tenderometers with respect to the mean values of large samples. This indicates that the denture tenderometer gives information on raw peas which is significant in quality determination since the American Can Tenderometer has been previously validated with respect to several important quality indices of raw peas such as subjective evaluations and alcohol-insoluble solids content. Conversely, the Canco tenderometer is validated since it is shown to give results which are of significance in comparison to a mechanical process of human chewing (i.e., the denture tenderometer) which has been separately validated by subjective tests *(5)*.

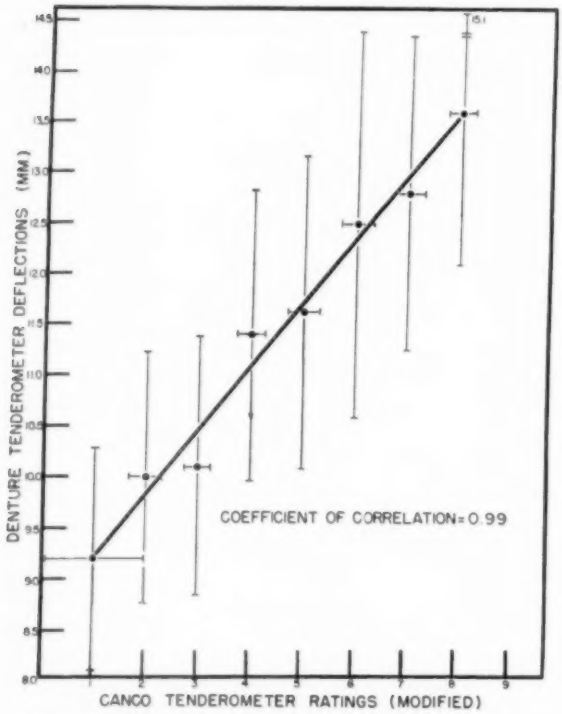

Figure 2. Curve showing correlation of denture tenderometer readings with Canco Tenderometer ratings.

The large ranges of values obtained by the denture tenderometer in a given sample must be interpreted as being due largely to the variations of individual peas in the sample, since individual peas were measured and the range of values obtained far exceeds the limits of error due to instrument precision as previously reported *(6)*. (The effect of unit size was eliminated by choosing peas of comparable size).

The corresponding ranges of values obtained with the Canco tenderometer are smaller in every case with the exception of grade one. (This grade represents 100 force units rather than the ten force units represented by the other grades). This disparity is considerable and leads to the conclusion that the Canco tenderometer, by its use of large samples gives a mean value of considerable significance in regard to overall average quality but tends to obscure variations of individual peas in a sample.

The present design of the denture tenderometer is adapted for research purposes. The instrument requires the use of skilled personnel and cannot perform measurements with great speed. Nevertheless, the principles involved may be used for the design of practical instruments for the testing of specific foods. This may be accomplished by using only those motions and dental surfaces found to be of importance for the specific food and operating these in a continuously operating arrangement which handles a large number of units in a short time, by automatic feeding and self-cleaning mechanisms. The resultant instrument could thus give rapid indications of both average quality and uniformity of the product.

CONCLUSIONS

The results on the denture tenderometer have shown a high degree of correlation with subjective panel results and with the Canco tenderometer. One of the outstanding advantages of the denture tenderometer shown in these tests is the ability to test individual peas and thus give a picture of uniformity as well as average quality.

Acknowledgment

The authors wish to express their appreciation to Mr. Raymond Wakefield, Director of Research of the Gerber Foods Company, Fremont, Michigan, for his cooperation and use of facilities in obtaining data for Figure 2.

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Observations on Pre-Peeling of Potatoes

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PRE-PEELED POTATOES are commercially prepared by peeling, treating with sulfur dioxide in a manner to prevent discoloration, and refrigerating to prevent bacterial spoilage. The general aspects of commercial pre-peeling of potatoes were presented by Olson and Treadway *(5, 6)* in 1949. Further details were subsequently published by Treadway and Olson *(7)*, Mullins, Olson, and Treadway *(4)*, Garrott and Merker *(3)*, and Garrott *(1, 2)*.

This communication is a report of recent investigations of the authors, during which they used a well-equipped laboratory and observed commercial operations in an establishment with a capacity in excess of 6,000 pounds of processed potatoes per hour. Subjects covered include raw material selection, low-temperature caustic peeling, materials handling, heat transfer and refrigeration requirements, and other related problems.

RAW MATERIAL SELECTION

Selection of suitable raw material is a major factor in successful operation. Size, condition, and quality of potatoes have an important bearing on processing costs and product quality. These factors must be weighed against cost and quality of potatoes available for purchase. There is probably no substitute for accurate production records and experience in a successful purchasing program. For a beginning operator, a few general statements may be helpful, but the experience gained by day-to-day decisions on potato purchases, if correlated with operating costs, will provide the basis for continuing success. Lower-priced, poor-quality potatoes may prove to be more costly than a better raw material, because of reduced product yield, higher trimming costs, and perhaps customer dissatisfaction if product quality is not maintained.

Because larger potatoes have less peel per pound, lower peeling losses and labor costs result when they are processed. Further, a greater percentage of usable French-fry cuts can be produced from them and most of the current demand is for French-Fry size. If feasible, potatoes should be size graded and the small sizes utilized for whole-peeled potatoes and hash-browned stock.

The loss of yield and increased labor due to extra trimming required to produce a peeled whole-potato product increases costs, so that small whole-peeled potatoes cannot be produced for as low a cost as those used for French-fry cuts. This difference increases in localities where the trade accepts small skin fragments on French-fry cuts.

Selected varieties can also alter production costs, in that peeling and trimming operations may necessarily be adjusted to each variety as the seasons progress.

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LOW-TEMPERATURE LYE PEELING

Peeling of fruits and vegetables with lye has long been a common industrial practice. Depending upon the commodity being processed, hot or boiling lye at concentrations varying from about 3 to 25% are normally used. Some potato pre-peeling operators have used the higher temperatures, but the resulting cooked surface has sometimes been considered unacceptable, or nearly so, by the restaurant trade. This cooked surface may become tough during subsequent storage and it is especially important if whole-peeled potatoes are the product and mashed potatoes are to be prepared therefrom.

If a cooked layer due to peeling exists, then the partially denatured, heat-activated enzyme system will cause intense darkening at the boundary between the cooked layer and the rest of the tuber. The normal preservative action of the sulfur dioxide used to prevent discoloration appears unable to control the darkening at this boundary and stronger treatment is often used. In addition, bacterial spoilage is more noticeable on the cooked surfaces than on the non-cooked areas of the same tuber.

Low-temperature lye peeling (peeling below or at the temperature range of starch gelation on whole potatoes), as suggested by Olson and Treadway *(5)*, was developed to minimize or avoid the formation of a cooked layer with retention of the advantage of chemical peeling in which peeling loss is less influenced by the shape of the potato.

A small-scale laboratory experiment shows the interrelationship of temperature and lye concentration with time for peeling U. S. No. 1 Russet Burbank potatoes with a minimum of growth cracks and other defects. In Figure 1 immersion time for adequate peeling at different lye temperatures is one coordinate and lye concentration the other. The amount of peeling was measured by weight loss due to the removal of the lye-affected peel by jet-spray washing. Optimum lye concentration in these experiments was 15-20% and, as expected, immersion time for adequate peeling decreased as lye temperature increased. A trend toward poorer peeling was observed with 25% lye at the lower temperatures. At 10% lye concentration, appreciably greater time was required for peeling. In this experiment, peeling losses were about 9%. (This figure does not include the trimming loss that would be required in normal pre-peeling operations.) Thus, over the employed range of conditions, peeling loss was fairly constant for a given lot of potatoes. Adjustments of concentration, time, and temperature were necessary to obtain the most economically peeled product as different lots of potatoes were used. In general, the amount of loss above minimum depends primarily upon the quality or grade, variety, and size of potatoes peeled. Al-

though laboratory findings in regard to effect of temperature of lye on quality of peeled product (cooked-surface layer) were in general confirmed in plant-scale operations, the variation in commercial lye peeling requirements for different varieties could not be accurately predicted on the basis of small-scale laboratory tests. When peeling temperatures close to the gelatinization point of starch (150° to 160° F.) were used, the effect of heat on product quality was noticeable. Generally a smooth glazed appearance was observed in contrast to the pitted raw appearance of potatoes peeled at 130° and 140° F.

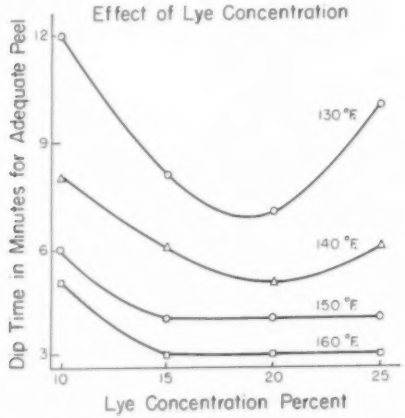

Figure 1. Effect of lye concentrations at low temperatures on peeling.

In the plant operations the peeling solution for whole-peeled potatoes was kept below 145° F.; for the French-fry cuts 158° F. was used as a maximum. This difference was predicated on differences in quality requirement for French-fry cuts and whole-peeled potatoes. (The cut potatoes do not require complete removal of peel and have an increased specific surface so that the adverse effects of original surface were less apparent.) The objective of commercial operators for clean peeled potatoes may vary with the type of product produced (whole or cut potatoes) and with the wide range of quality between tubers to be peeled as one lot. For maximum efficiency in terms of yield and labor costs, a small percentage of tubers will not be adequately peeled in the lye bath and will require hand trimming. Complete lye peeling would seriously reduce yields.

With continued use, the viscosity of the lye solution increases due to solution of potato components and its peeling efficiency is reduced, although its alkali content is kept substantially unchanged by make-up. To restore peeling efficiency at reduced temperatures, periodic replacement of the lye solution was necessary. In this commercial operation, the costs attributed to the lye solution was estimated at about 6 cents per cwt. of potatoes processed. It is expected that a pre-washer could be used to remove dirt and foreign matter from the potatoes and extend the useful life of the lye solution.

An integral part of a low-temperature lye-peeling operation is a well-designed washer for prompt removal of the lye-affected tissue. The conditions of lye immersion and wash-water pressure are usually based on experience and must be adjusted as the quality of potatoes changes. A post-peeling acid bath to neutralize the product was used under some commercial conditions but may not be necessary if washing operations are adequate.

A comparison of low-temperature lye peeling and abrasion peeling was made. The commercial plant observed had experience in both peeling methods over a long period of time but not simultaneously, so that estimates of yield of product and labor requirements for French-fry cuts are only approximate. Data are presented in Table 1, based on local conditions of operation over a 2-year period with high-quality raw material having a minimum of rot and growth cracks.

TABLE 1

Comparative product yield and trimming labor with low temperature lye peeling and abrasion peelings[1]

Potato variety	Low temperature lye		Abrasion peeling	
	Product yield	Trimming labor unit	Product yield	Trimming labor unit
Russet Burbank	86%	1½	75%	3½
Early White Rose	75%	1	91%	1

[1] Estimates based on good potatoes—minimum of rot, bruises and growth cracks—prepared as French fry cuts.

Advantages of low-temperature lye peeling under these local conditions were evident for the late-crop Russet Burbank potatoes. On the other hand, abrasion peeling was more economical for the early-crop White Rose variety, because the very light skins of the latter need not be as completely removed as the dark corky peel of the russeted variety. The regular shape and shallow eyes of the White Rose potatoes make them well suited for abrasion peeling and they require relatively little trimming. Further, this variety is used soon after harvest and if high-quality material is procured, the mechanical damage and rot are negligible. On the other hand, the peel of the White Rose variety, although very thin, appears peculiarly resistant to chemical attack of the lye, and longer peeling times and higher lye peeling losses than for Russet Burbanks are often encountered.

MATERIALS HANDLING PROBLEMS

After trimming or sorting, the peeled potatoes were cut to the desired size for French-fry cuts. The two varieties mentioned produce elongated-oval tubers. For these varieties, hand positioning for cutting was often used. When cut at random the advantage of greater length of the tuber and of the resulting French-fry cuts was lost. The Kennebec variety, having a rounder shape, did not benefit as much from hand positioning before cutting as did the Russet Burbank or White Rose.

Following the cutting operation, a spray washer was used to remove much of the free starch from the cut surfaces and to wet the pieces so that the small slivers and short cuts adhered to the carrying belt and were removed from the larger, more uniform product.

To prevent discoloration the washed, sorted, and

drained product was treated by dipping in a solution of sodium bisulfite. The treatment could be altered either by varying the concentration of the bisulfite solution or by changing the immersion time as required by the potatoes being processed or by quality of the product desired. It was found necessary to use a somewhat stronger solution for some of the early varieties than for the later potatoes to obtain similar color stability.

After removal from the dipping solution, the cuts were passed over a dewatering reel before packaging. Rapid cooling of the peeled product is an essential feature of pre-peeling operations and success of the operation may depend upon adequate systems for refrigeration.

HEAT TRANSFER AND REFRIGERATION

Temperature of peeled potatoes should be maintained below 40° F. to prevent microbial spoilage. The perishability of pre-peeled potatoes is comparable to that of milk and meat. Even under refrigeration, spoilage will eventually result, but storage life can be extended by maintaining high sanitary levels to prevent undue contamination.

Many pre-peeling operations have been obesrved in which refrigeration was limited to a low-temperature room in which packaged product was stored for a period of time before delivery to customers. Although the product when packaged may have cooled rather slowly, if bacterial contamination was kept at a low level and if reasonable air circulation in the cold room existed, a satisfactory storage life resulted.

For a larger operation, as required for increased production rate of the plant considered in this study, further refrigeration was essential. The packaged product was moved on pallets holding thirty to fifty 30-pound packages. Observations with fifty 30-pound packages of French-fry potatoes on a pallet showed that the temperature of the product in the center of the load was about 70° F. Fifteen hours later the internal temperature of this pallet load was still very near 70° F. even though the refrigerator was kept at 40° F. and air was circulated with a fan. The placement of 26-gage corrugated metal sheets between the bags of product improved the heat transfer from the potatoes, as did an improved method of stacking to provide better air circulation. Even these expedients did not appear adequate.

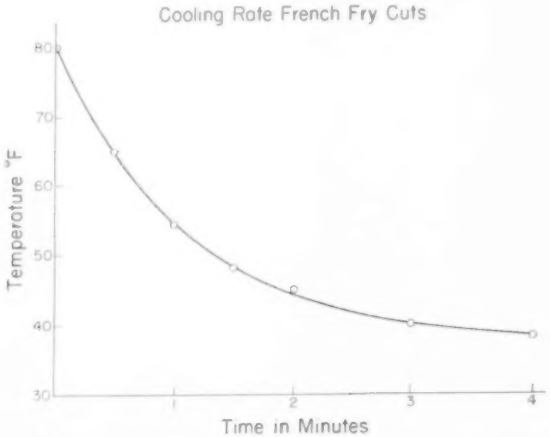

Figure 2. Cooling rate for French-fry cuts by a refrigerated solution maintained at 34° F.

Because heat transfer is slow after packaging, it appeared desirable to cool the product before packaging. Efficient cooling of French-fry cuts was accomplished by refrigeration of the bisulfite treating solution used to prevent discoloration. With adequate agitation of the product and solution, the temperature of ⅜-inch cuts was reduced below 40° F. when packaged after a 1.5-minute immersion in the treating solution refrigerated to 34° F. (Figure 2 shows the internal temperature drop per unit of time for ⅜-inch French-fry cuts when placed in water at 34° F.)

Although it was not feasible to cool whole peeled potatoes below 40° F. by a short immersion in the refrigerated treating solution, the effectiveness of such a treatment can be seen in Figure 3. Curve A represents

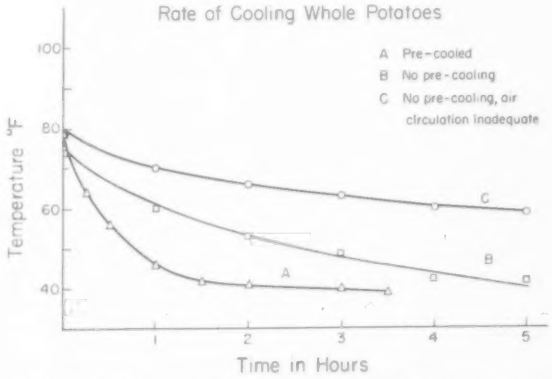

Figure 3. Air cooling rate for whole peeled potatoes under varied refrigerator conditions.

temperature change at the centers of potatoes held in a wooden box one layer deep at 40° F., with circulation of air, following a 5-minute dip in bisulfite solution at 34° F. In one hour the internal potato temperature had dropped below 50° F. from an initial center temperature of 79° F. For comparison, potatoes that had not been pre-cooled were placed in the refrigerator in an open wooden box and the center temperature was charted as curve B. Although the 5-minute dip did not cool the product to the desired low temperature (curve A), it removed sufficient heat so that the product cooled at a rate about twice that of the sample that was not pre-cooled (curve B).

Simulating the conditions of whole potatoes stacked without pre-cooling or aedquate air circulation, curve C represents center temperature of potatoes held in a 30-pound metal can in a 40° F. refrigerated room.

In plant practice, the immersion of the tubers for 5 minuts in bisulfite solution at 34° F. removed sufficient heat so that the product temperature was about 50° F. when packaged. This indicates the importance of adjustment of refrigerator capacity to production levels. Commercial establishments have been observed where operations have grown beyond the theoretical capacity

of existing equipment to cool the product as required for adequate preservation.

Figure 4 shows a sample calculation of refrigeration horsepower requirement to cool 6,000 pounds of cut potatoes per hour, from 85° F. to 35° F., by refrigeration of the preservative solution. The horsepower requirement for cooling the preservative solution for

Refrigeration Requirement

$$HP = \frac{BTU}{\text{Refrig. Factor}} = \frac{W \times c_p \times \Delta T}{\text{Refrig. Factor}}$$

$$= \frac{6000 \times 0.93 \times (85\,^{\circ}F - 35^{\circ})}{12{,}000 \times 0.75^{*}} \qquad HP = 31$$

*Assumed 25 % loss

W = weight of product cooled
c_p = specific heat
ΔT = range of temperature

Figure 4. Refrigeration requirement for a pre-peeling plant.

whole-peeled potatoes was not as great as for the French-fry cuts because part of the heat was removed more slowly in the refrigerated room, where auxiliary refrigeration was available. The refrigeration requirements should be established in designing or remodeling a pre-peeling plant by estimating operations for French-fry cuts, whole peeled potatoes, and other products.

RELATED PROBLEMS

Color of fried products. A continual problem in any phase of the potato business where deep-fat frying (e.g., chipping and French-frying) is involved is the procurement of potatoes that will fry to the desired color. This problem is often solved by test frying and careful buying of potatoes with the proper frying characteristics. This is not always possible or economical. Conditioning potatoes at elevated temperature is sometimes used but also is expensive in space, labor, and spoilage. Thus it may be necessary, under some conditions, to provide a more direct control of the ultimate product color even from poor raw material.

In laboratory observations, it was shown that there was some reduction in dark fry color afforded by a short treatment with sulfur dioxide. A greater color reduction was observed if the 3/8-inch French-fry cuts were leached in hot water (160° F.) for 3 minutes. Of course more reduction in color was noted if both leaching and sulfiting were used or extended. Five-minute leaching and a one-minute dip in SO_2 solution (0.5%) produced a very light-colored product in an experiment with potatoes that otherwise gave a fried product too dark for acceptance. Careful control of leaching is necessary to obtain the desired end product.

Preparation of hash-browned potato stock. Efficiency of operation and service to customers are important factors in the pre-peeling industry. The preparation of hash-brown potato stock is a way of increasing both. The uniformity of product in the French-fry line depends to some extent upon removal of short pieces and side cuts. If a very uniform product is desired, as much as 10% of the product may require removal, depending upon size and quality of potatoes used and method of cutting. Uniformity of product can also be aided if small tubers are removed prior to cutting or peeling. Small tubers and small cuts can be converted into hash-brown potato stock by a process such as is outlined in the production flow diagram presented in Figure 5.

In laboratory experiments on hash-brown potato stock, small whole-peeled potatoes were cooked, cooled, shredded, and combined with shreds made from undersized cuts from the French-fry cutter after washing, cooking, cooling, and shredding. The proportion in the final product was 2 weight units of shreds from whole tubers to one from the undersized cuts. Such a ratio was necessary to obtain proper frying characteristics of the product.

In preliminary commercial trials, it was found that pressure cooking and allowing the cooked product to remain wet by the condensation of steam or any excess water were not conducive to production of a good product. Atmospheric steam cooking on wire trays of shallow bed depth was employed. After cooking, adequate provisions were made for cooling the product to

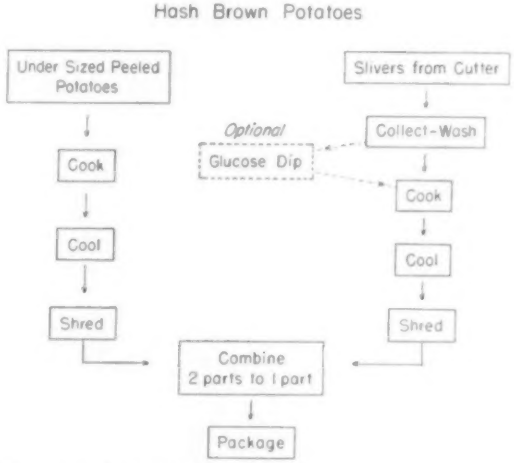

Figure 5. Flow diagram for preparation of hash-brown potato stock.

room temperature in a manner that would avoid contacting the condensing steam.

Cooling of the cooked whole potatoes to room or refrigerated temperatures and holding at these temperatures for several hours was used to facilitate cutting and avoiding mashing during shredding into 1/8-inch cuts.

The small cuts from the French-fry line tended to darken while being collected unless held in water or a very dilute bisulfite solution. If discoloration of the small cuts occurred before cooking, the final product was apt to appear gray when fried. Holding these small pieces in water and washing to remove free starch caused leaching, which could be partially compensated by dipping the small cuts in a glucose solution (3 to 5%) before cooking to improve their browning characteristics upon frying. Extra attention to plant sanita-

tion and refrigeration was required for production and distribution of hash-browned potato stock because of the added possibility of contamination during shredding and mixing, greater difficulties of heat transfer from this packaged material, and greater susceptibility to microbial spoilage of a cooked than a raw potato.

Miscellaneous observations. In all phases of studies reported here, there were continual reminders of the wide difference between laboratory or kitchen experimentation and plant practices. Examples were noted in the application of low-temperature lye peeling. In experimentation or small operations the ease of agitation of the lye bath and more uniform transfer of heat from lye to potatoes gave good peeling in shorter immersion times than was normally obtainable in the plant. Because high-quality raw material was used for laboratory work, there was only a minor problem of accumulation of dirt in the laboratory lye bath compared to that at the plant. Lye solutions in the laboratory were never used to the exhaustion of peeling capacity.

Major differences in quantities processed affected product quality. This became especially noticeable in the production of hash-brown potato stock, which will crush to a mash if handled in large quantities while still hot.

The problems of cooling, sanitation, and product contamination are sometimes magnified so as to be almost insurmountable in a plant. A few hours' delay in cooling the center of a large mass may create considerable spoilage or souring.

The timing of operations in the commercial line caused differences in the accomplishment of some procedures. For example, the cooling off of a lye-treated potato prior to exposure to pressure washing may result in incomplete removal of lye-affected tissue.

In laboratory experiments, each operation can be treated separately. The interrelations of processes, when production must be geared to delivery schedules of different products, are impossible to simulate in small-scale experiments and must be worked out in actual practice.

SUMMARY

Laboratory experiments and observations of commercial operations have helped to elucidate several factors in the peeling of potatoes for marketing as peeled or otherwise prepared products. (a) For example, low-temperature (below 160° F.) lye peeling is a feasible commercial operation that generally results in reduction of peeling loss and trimming labor as compared with abrasion peeling. The advantages of low-temperature lye peeling are offset slightly by a decrease in resistance to spoilage and the occurrence, in large-scale operations, of occasional areas of surface cooking. These advantages are unobtainable with early-crop White Rose potatoes, but because of thin skins, shallow eyes, and regular shape this variety can be peeled by abrasion with high product yield and low trimming cost. (b) Rapid cooling of pre-peeled potatoes is essential to obtain maximum protection against microbial spoilage and discoloration. Refrigeration of the treating solution is a practical method for reducing product temperature to 40° F. within a few minutes for French-fry sticks. On the other hand, whole potatoes do not cool enough during treatment immersion and must be further cooled by adequate air circulation in refrigerated storage rooms. (c) If desirable, color intensity of French-fried potatoes can be reduced by a hot-water blanch before frying. (d) Undersized potatoes and small cut pieces that are not suitable for French-fry sticks can be processed to make salable hash-browned potato stock for use in restaurants.

Acknowledgment

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Antibiotics in Food Preservation. II. Studies on the Influence of Subtilin And Nisin on the Thermal Resistance Of Food Spoilage Bacteria[a, b]

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(Manuscript received May 13, 1956)

LeBlanc, Devlin, and Stumbo *(6)* reported that low concentrations of subtilin reduce the thermal resistance of a putrefactive anaerobe (P.A. 3679) and *Clostridium botulinum* 62A. Similar data for nisin were reported by Lewis, Michener, Stumbo, and Titus *(8)*. The work of Michener *(8, 9)* and O'Brien and Titus *(10)* has shown that this effect may be caused by the carryover of antibiotic into the subculturing medium. The literature on this and other aspects of antibiotics in food preservation has been reviewed recently by Campbell and O'Brien *(2)*.

This paper summarizes investigations of the effect of subtilin, nisin, and other substances on the thermal resistance of spores of a variety of bacteria important in the spoilage of thermally processed foods.

EXPERIMENTAL

Preparation of spore suspensions. Spore suspensions of P.A. 3679 and *C. botulinum* strains were prepared as described by Stumbo, Murphy, and Cochran *(15)*. Spore suspensions of *Bacillus stearothermophilus* 1518 and *Bacillus coagulans* 43P were prepared according to Youland and Stumbo *(17)* except that nutrient agar was employed as the sporulation medium. *Clostridium thermosaccharolyticum* 3814 spores were produced in pea extract according to Baumgartner *(1)* except that agar was omitted. All spore suspensions were stored at 40° F. in bottles containing about an inch of glass beads.

Estimation of spore concentrations. Spore concentrations of all suspensions were estimated by a dilution method (with counts of viable and sterile tubes) as described earlier *(14, 15)*. Spore counts were made in Yesair's medium prepared according to Wynne and Foster *(16)* except that thioglycollate supplement was omitted.

Determination of thermal resistance. The thermoresistometer technique described by LeBlanc *et al. (6)* was used. Except as otherwise mentioned, the heating menstruum was pea puree, the temperature 250° F., the subculturing medium Yesair's without thioglycollate supplement, and the incubation period 90 days at 85° F. *D* values were calculated as previously described *(14)* except that in experiments on the effect of the initial number of spores, the mean time required for sterilization of aliquots was estimated together with a standard deviation by the Spearman-Karber method *(4)*. The problem of estimating *D* values from binomially-distributed data, including these calculations, has been reviewed by Lewis *(7)*.

All antibacterial compounds were obtained through the Western Utilization Research Branch, U. S. Department of Agriculture, who in turn are indebted to a great many companies and individuals for gifts of the substances.

RESULTS AND DISCUSSION

The major part of this study comprised an attempt to find factors that would influence the extent of the reduction in *D* values by subtilin and nisin. Inasmuch as many factors were without significant influence, it will suffice in most cases to indicate the range of the variables studied.

Representative data presented in Table 1 show a reduction in *D* value for all bacteria tested except *C. thermosaccharolyticum* 3814. The question of whether the lack of response of this strain is typical for this species remains to be determined; only one preparation of spores was tested. It may be noted that its heat resistance was relatively low when compared with that reported by Reed, Bohrer, and Cameron *(12)*. Over 100 parallel determinations of *D* values in the presence and in the absence of subtilin have been made, and over 30 for nisin. Except for *C. thermosaccharolyticum* 3814, subtilin and nisin have always reduced the *D* value, the greatest reduction being that shown for *B. coagulans* with nisin (Table 1).

No effect of antibiotic on *z* value was found for nisin with P.A. 3679 at temperatures of 240, 250, 260, and 270° F. or for subtilin at 230 and 250° F. for the strains of *C. botulinum* (62A was not tested), confirming the report of LeBlanc *et al. (6)*.

Purees of peas, corn, broccoli, cauliflower, sweet potatoes, and green beans were used as suspending menstra for P.A. 3679 and *C. botulinum* 62A for tests

TABLE 1

Effect of subtilin and nisin on D values for various strains Spores suspended in pea puree

Strain	Temp. (° F.)	Initial number per aliquot	*D*, no antibiotic (min.)	*D*, as % of control, in presence of:	
				Subtilin[1]	Nisin[2]
P.A. 3679	250	22,500	1.45	49	40
C. botulinum 62A	250	20,000	0.129	62	58
C. botulinum 25B	250	156,000	0.158	14	22
C. botulinum 213B	250	152,000	0.119	21	[3]
C. botulinum 1398B	250	75,000	0.069	36	[3]
C. botulinum 3A	250	84,000	0.063	65	[3]
C. botulinum 240A	250	311,000	0.015	56	[3]
C. thermosaccharolyticum 3814	250	28,000	0.61	163	111
B. coagulans 43P	225	800	1.00	36	7
B. stearothermophilus 1518	250	4,400	1.82	39	30

[1] Equivalent of 14 p.p.m. countercurrent-distributed subtilin. Material used had 57.5% of this potency.

[2] Equivalent of 14 p.p.m. nisin of potency 4×10^7 units per gram. Material used had 25% of this potency.

[3] Not tested.

[a] Scientific Paper No. 1495, Washington Agricultural Experiment Stations, Pullman, Project No. 1101.

[b] A report of work under a contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Western Utilization Research Branch, Agricultural Research Service.

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of the effect of subtilin, and purees of peas, sweet potatoes, and green beans for P.A. 3679 and nisin. *D* values in the presence of antibiotic ranged from 26 to 63% of *D* values for controls.

Pork infusion, liver infusion, and nutrient broth were also used as suspending media for the same organisms with and without subtilin. The reduction in *D* values in the presence of subtilin was smaller than with vegetable purees, especially for *C. botulinum* 62A in pork and liver infusion where the presence of subtilin gave *D* values equal to 85 and 78% of the controls, respectively.

The adjustment of pea puree to pH 7.5, 6.5, 5.5, and 4.5 for tests of P.A. 3679 with and without subtilin or nisin gave *D* values for the presence of antibiotics that varied from 37 to 70% of the control *D* values. The control *D* values showed the expected dependence on pH, being about one-half as large at pH 4.5 as at pH 7.5. pH adjustments were made with sodium hydroxide or hydrochloric acid. In addition, acetic, sulfuric, phosphoric and nitric acids were used at pH 4.5; at pH 7.5 ammonium and potassium hydroxides were also used. The percentage reduction of *D* values in the presence of subtilin or nisin was not affected by pH. Similarly, the agents used for adjusting the pH had no effect on the percentage reduction in *D* value.

P.A. 3679 was heated at 250° F. in pea puree with and without subtilin, and subcultured into infusions of brain heart, liver, pork, peas, green beans, corn, cauliflower, broccoli, potato, and corn steep-skim milk solidified with agar. The control *D* values varied from 1.02 to 1.57 and the *D* values in the presence of subtilin varied from 40 to 78% of these values.

Nisin concentrations of 3.5, 7, and 14 p.p.m. were compared in pea puree with P.A. 3679. The lowest concentration gave a marked effect, but somewhat less than was obtained with 7 or 14 p.p.m. A combination of 7 p.p.m. subtilin plus 7 p.p.m. nisin gave identical results as 14 p.p.m. subtilin or 14 p.p.m. nisin.

On various occasions, incubations were continued for 9 months at ambient room temperature after 3 months at 85° F. No change was observed with the controls in any case, nor in the presence of subtilin with P.A. 3679 or *C. botulinum* 62A. However, increased spoilage in subtilin-treated pea puree was observed for *C. botulinum* strains 25B and 240A between 90 days, 180 days, and 1 year.

Deviations from negative exponential survival ("logarithmic order of death") were apparent in some experiments in which the initial number of spores was varied. Two experiments with P.A. 3679 are shown in Figure 1. The logarithm of the probability (π) that an individual spore survives is plotted against time of heating. This probability is the ratio N/N_o where N is the average number of viable spores per tube after heating and N_o is the original number before heating. A modified method of calculation (*7*) estimates the time at which $N = 0.54$ and also gives an estimate of the standard deviation for this time. This makes possible the calculation of 95% confidence intervals for this time, as shown by the horizontal bars in Figure 1.

It may be seen that the control for suspension I (no antibiotic present) does not depart significantly from linearity (negative exponential survival), but that the control for suspension II does. The type of departure is that to be expected from a mixed population of varying resistance, each homogeneous fraction of which follows exponential survival (*11*). The plot of log π *vs.* time approaches a slope that is determined by *D* for the most resistant class in the population; that drawn for the controls corresponds to $D = 1.55$ minutes.

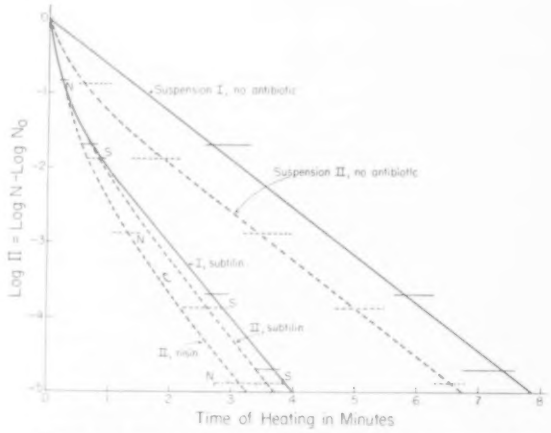

Figure 1. Probability of an individual spore surviving plotted against time of heating. P.O. 3679 in pea puree in the presence and in the absence of subtilin or nisin. Confidence limits 95%.

The plots for heating in the presence of subtilin or nisin show marked departures from linearity. This points to heterogeneity in the spore suspensions with respect to responsiveness to the antibiotics. It points to the possibility of isolating strains wth increased resistance to the antibiotics (so far as effect on *D* value is concerned).

These results make values of *D* determined from a single inoculum concentration quite arbitarary inasmuch as nothing is demonstrated regarding homogeneity of the spore suspension used. It is well-known that overall resistance of spore-populations is influenced by many factors. The difficult problem of characterizing nonhomogeneous populations cannot be considered here. The demonstration of an effect of an antibiotic is not invalidated by these considerations, however, inasmuch as control and antibiotic-treated samples from the same spore suspension were always treated in parallel.

A more serious consideration arises from the presence of the antibiotic in the subculture medium since the sample of puree, spores, and antibiotic is dropped directly into the recovery medium. The volume ratios of approximately 1 to 1,000 ostensibly would give a concentration of 0.014 p.p.m. in the recovery medium in the usual case. In fact, the purees dispersed very poorly so that the antibiotic concentration near the spores would remain higher than 0.014 p.p.m. until reduced by the relatively slow process of diffusion and of inactivation during incubation. Shaking the tubes to secure dispersal was avoided lest the medium become aerated; instead the tubes were placed at once in cold water to solidify the agar.

O'Brien and Titus *(10)* under the conditions of this study and Michener *(8, 9)* in experiments with *B. subtilis* 9524 have shown that outgrowth of severely-heated spores is reduced by much lower concentrations of subtilin than outgrowth of spores that have not been heated severely. It appears that this phenomenon may be sufficient to explain the effect of subtilin and nisin in reducing *D* values. O'Brien and Titus *(10)* reported that with severely-heated spores of P.A. 3679 subcultured without subtilin and with 0.01 p.p.m. subtilin the most probable number of spores surviving was 14 and 5 respectively. The initial number was approximately 1.67×10^2 per 48 tubes. Therefore, the ratio of *D* values with and without subtilin is:

$$\frac{D_{0.01s}}{D_{0s}} = \frac{\log N_o - \log N_{0s}}{\log N_o - \log N_{0.01s}} = \frac{2.223 - 1.146}{2.223 - 0.699} = 71\%$$

Thus the reduction in *D* value is within the range observed for the presence of subtilin during heating. Substantially higher subtilin concentrations in the neighborhood of the spores in the recovery medium occur in the experiments for the estimation of *D* values. The effect of subtilin in the recovery medium on heat-damaged spores appears to account for most, if not all, of the reduction in thermal resistance in the presence of subtilin. The failure of LeBlanc *et al. (6)* to observe this effect in a small number of experiments may arise from the circumstance that severely heated spores were added in one aliquot of pea puree and the subtilin added in a second aliquot of pea puree. Under these conditions it is probable that the subtilin did not readily diffuse into the immediate neighborhood of the spores.

Some experiments on the stability of subtilin were made by subjecting a 0.1% solution to 270° F. in the thermoresistometer and then mixing with heat-activated spores of P.A. 3679. By comparing the inhibition endpoint for mildly-heated subtilin, it was found that 50% destruction of the subtilin required about 7 minutes in one experiment and a longer period of heating in another experiment. It is clear that in no case was the destruction of subtilin significant during the heating process used in routine experiments. However, subtilin has been found to disappear from canned vegetables during incubation at ordinary storage temperatures *(3)*.

A number of other antibacterial agents were tested against P.A. 3679 in pea puree. In repeated experiments a reduction in *D* value, to 57 and to 67% of the control was observed for aureolic acid at 14 p.p.m. Questionable reductions were obtained with 14.0 p.p.m. colupulone [previously *(8)* misidentified as lupulone], 14.0 p.p.m. hygromycin, and *n*-butylthiosulfinate (saturated solution). The latter is a suitable analog of the antibacterial component of garlic *(13)*. Ineffective were garlic oil (100 p.p.m.), a concentrated water extract of garlic powder, sorbic acid and vitamin K_5 at 200 p.p.m., allyl isothiocyanate, β-(indole 3)-propionic acid, and β-(indole 3)-*n*-butyric acid at 100 p.p.m., and amphomycin, aterrimin complex, humulone complex, rimocidin sulfate, streptogramin, vulpinic acid, poly-L-lysine (n = 33 and 83), methyl-5-nitro-2-furfuryl ether, N-(5-nitro-2-furfurylidene)-3-amino-2-oxazolidone, and N-(5-nitro-2-furfurylidene)-1-aminohydantoin at 14 p.p.m. Certain of these are of interest for having been reported previously to show effects on the heat resistance of spores—see Lewis *et al. (8)*. The substances cited by Lewis *et al.* as achromycin and hexahydrolupulone are now known as puromycin and hexahydrocolopulone, respectively.

Of approximately 90 different substances reported here and in previous studies *(6, 8)* only four (subtilin, subtilin methyl ester, nisin, and aureolic acid) gave a significant reduction in the *D* value of the test organism. In a search for new thermal resistance reducing agents, a more efficient screening method would be useful. Outgrowth of severely-heated spores might be used as a test system for discovering such agents by spraying an inoculum of severely heated spores onto soil plates or by overlayering according to the method of Kelner *(5)*.

SUMMARY

Spores of various food spoilage bacteria appear to be appreciably less heat resistant when heated in the presence of subtilin or nisin. None of a variety of factors markedly affected the proportionate reduction in *D* values; among the factors tested were pH of the suspending medium, use of various purees for the suspending medium, temperature of heating, the subculturing medium, and the spore concentration. Deviations from negative exponential survival were demonstrated.

A possible mode of action of subtilin in reducing thermal resistance was discussed. Out of approximately 90 other antibacterial substances tested none was found to be so effective as subtilin or nisin in reducing the thermal resistance of spores of P.A. 3679, although aureolic acid showed some effect.

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Investigation of Copper Complexes Causing Cloudiness in Wines II. Bentonite Treatment of Wines

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Clouding of white table wines due to the presence of copper is one of the major problems confronting the wine industry today. In an earlier paper on this subject *(5)* proteins were shown to play an extremely important role in the formation of the copper cloud. This paper deals primarily with the protection of table wines against the adverse effects of copper by reducing the protein content of the wines.

When proteins are dispersed in wines, they exist in a state of colloidal micelles with positive electrical charges. Although proteins are present in white table wines only in trace quantities (0.01% or less) they are present practically always in isolated "cloud material" in very significant quantities *(60-70%)*.

The formation of turbidity of a protein nature, which one often finds accompanying the copper cloud, was noticed by Laborde *(6)* in France as early as 1904 and in Germany by German workers *(9)* in 1932. Laborde *(6)* recommended heating for the elimination of proteins while the German authors observed that ferrocyanide fining eliminated a part of the protein independently of the removal of heavy metals. These treatments for protein removal were far from complete and wines so treated were probably still susceptible to clouding.

In 1937 bentonite was introduced into Germany as a fining agent *(8)* but, unfortunately, did not gain wide acceptance or usage until years later. This, despite the fact that bentonite was shown to be much superior in its stabilizing effect to the organic fining agents such as gelatin, isinglass, casein, egg white and albumin. As commonly used, bentonite's primary function is to serve as a clarifying agent. In this connection, it has been frequently used with gelatin in both Europe and the U. S. by table wine producers. Bentonite, a negatively charged colloid, will combine with the native proteins and effectively reduce their concentration, yielding a wine of greater stability. This function, however, is lost largely when gelatin is used in combination with bentonite since most of the bentonite becomes "tied up" with gelatin. Thus, the gelatin-bentonite treatment results in a brilliantly clear wine, with an uncertain stability depending on the amount of protein remaining in the wine.

The purpose of the investigations discussed in this paper was to determine the effect of gelatin, bentonite, and gelatin-bentonite finings on susceptibility of white wines to copper clouding.

METHODS OF ANALYSIS

The methods of analysis employed were the same as those reported in an earlier paper *(5)*.

EXPERIMENTAL

The effect of bentonite on the stability of wines with respect to copper clouding during storage in bottles was tested in the following series of experiments. Two one-gallon samples of Wine No. 31 (analysis given in Table 1) were treated in the following manner:

1. *Wine No. 31-1*—No treatment.
2. *Wine No. 31-2*—Fined with 45 ml. of a 5% bentonite suspension equivalent to 5 pounds of bentonite per 1,000 gallons. The bentonite suspension was added to approximately 200 ml. of wine and the mixture was thoroughly mixed in a Waring blender for 30 seconds. This mixture was then added to the gallon of wine and mixed for 15 minutes with a slow bubbling stream of nitrogen. After standing overnight under room coonditions the wine was filtered through Whatman No. 2 paper.

Initially, both wines contained 78 mg. of protein per liter. After fining, the protein content of Wine No. 31-2 decreased to 2 mg. per liter.

Three and one third mg./l. copper (as copper acetate) was added to each of these wines, nitrogen was bubbled through for a few minutes to hasten reducing conditions, and the wines were then placed in a 45° C. (113° F.) incubator. After three days, Wine No. 31-1 was very cloudy, while Wine No. 31-2 remained perfectly brilliant. Nephelometer readings on Wine No. 31-1 after exposure to air, indicated that this cloud was completely irreversible.

* Present address: California and Hawaiian Sugar Refining Corp. Ltd., Crockett, California.

TABLE 1

Composition of wine No. 31 before treatment

Copper	0.2 mg./l.
Total Organic Nitrogen	455 mg./l.
Protein	78 mg./l.
Iron	6.6 mg./l.
Total SO_2	20 mg./l.
Free SO_2	4 mg./l.
Phosphorus	.0216%
pH	3.2

After 2 weeks both wines were still in the same condition as described above and at this time Wine No. 31-1 was filtered until brilliant. Copper and protein contents were determined on the clear-wines; the results are given in Table 2.

TABLE 2

Composition of wines before final cloud formation

	Copper	Protein
Wine No. 31-1	3.5 mg./l.	73 mg./l.
Wine No. 31-2	3.5 mg./l.	2 mg./l.

Two hundred fifty mg./l. sulfur dioxide was then added to each wine in the form of potassium metabisulfite. After bubbling nitrogen through each wine for 10 minutes, the bottles were sealed and placed in a 45° C. (113° F.) incubator. In one day a very heavy cloud formed in Wine No. 31-1 while Wine No. 31-2 remained perfectly brilliant. After five months Wine No. 31-2 was still perfectly clear. The cloud material formed in Wine No. 31-1 was partially reversible upon exposure to air as determined nephelometrically.

Under the conditions described above (i.e., very low protein, no sunlight), cloud formation did not occur in Wine No. 31-2 even though it contained a large amount of copper, a high concentration of sulfur dioxide, and was stored at a high temperature for a long period of time. This appears to indicate the necessity of protein for cloud formation in white wines stored in the dark at elevated temperatures.

In other experiments, protein reduction with potassium ferrocyanide or with the proteolytic enzyme pepsin in conjunction with bentonite, were found to be inferior to straight bentonite fining.

Rapidity and thoroughness of protein removal by bentonite added in different ways. It has long been suspected that the protein content of wine and wine stability are interrelated. Preceding experiments have shown that bentonite very effectively lowered the protein content of wines and also increased the stability of the fined wine. The following experiment was done to determine how rapidly and thoroughly protein is removed from a wine by the use of bentonite suspensions.

Ten gallons of white table Wine No. 50 (composition given in table 3) were placed in one 5-gallon bottle and five 1-gallon bottles.

All lots were made brilliantly clear by filtering through Whatman No. 2 paper, before subjecting them to bentonite treatments. The method by which bentonite was added and the amounts used, in terms of pounds per thousand gallons, are shown in Table 4. Suspension of bentonite was maintained by the continuous bubbling of N_2 through the wine during the test. Wine samples were removed after various time intervals, filtered through Whatman No. 2 paper and analyzed for protein content.

Results indicate that the amount of protein removed from any particular wine is dependent upon both the amount of bentonite added and the method of addition. Furthermore, the variety of wine is an important factor in determining the amount of protein removed by a bentonite treatment, as shown in Table 6.

TABLE 3

Composition of white table wine No. 50

Ethyl alcohol	13.3%
Total Nitrogen	415 mg./l.
Protein	49 mg./l.
Iron	0
Copper	0
Free SO_2	0
Total SO_2	85 mg./l.
pH	4.05

Mixing a 5% bentonite-wine suspension with a small quantity of wine (about 100 ml.) in a Waring blender before adding to the test sample of wine resulted in better protein removal than when the bentonite suspension was added directly. The direct addition of powdered bentonite to wine resulted in the poorest protein removal. For this particular lot of wine one pound of bentonite per 1000 gallons of wine was insufficient for effective protein removal whereas 3 pounds of bentonite per 1000 gallons gave excellent results if first mixed by use of the blender technique described above. Practically all the protein adsorbed by bentonite was removed during the first half hour after bentonite treatment although a further reduction occurred very slowly over a longer period of time. Nevertheless, a small amount of protein always remained regardless of how long the bentonite was in contact with the wine.

TABLE 4

Effect of bentonite treatment on removal of protein from wine

Wine	Amount of bentonite used	Method of adding bentonite[1]	Protein content of wine (in mg./l.) after							
			0 hr.	½ hr.	1½ hrs.	3 hrs.	7½ hrs.	11 hrs.	24 hrs.	48 hrs.
50-4-0	5 lb./1000 gal.	1	49	7.5	7.5	7.3	6.9	6.5	6.4	6.2
50-4-1	3 lb./1000 gal.	1	49	8.8	8.3	7.6	7.6			
50-4-2	1 lb./1000 gal.	1	49	20.5	19.7	19.1	19.7			
50-4-3	5 lb./1000 gal.	2	49	9.3	8.1	8.4	8.4			
50-4-4	3 lb./1000 gal.	2	49	11.3	11.3	10.9	10.3			
50-4-5	5 lb./1000 gal.	3	49	16.4	14.4	11.6	10.8			

[1] Method of adding bentonite:
1—Five percent bentonite suspension to aliquot of wine in Waring blender; mixed 15 seconds. This was added to remainder of wine and mixed by a stream of nitrogen.
2—Five percent bentonite suspension was poured directly into wine and mixed by bubbling nitrogen through it. Waring blender was not used.
3—Powdered bentonite was added.

even when up to 5 pounds of bentonite per 1000 gallons of wine were used.

Effect of bentonite treatment on the rate of copper clouding during storage in sunlight and in the dark at elevated temperatures. A description of the wines used and the treatments they had undergone prior to use in these tests are shown in Table 5.

TABLE 5

Winery treatment of commercial wines

Variety of wine	Winery treatment (per 1000 gallons of wine)
Sauvignon Vert	1 lb. bentonite + ⅛ lb. gelatin
Semillon	1½ lb. bentonite + ⅛ lb. gelatin
White Pinot, Press	1½ lb. bentonite + ⅛ lb. gelatin
Sylvaner 1952 Sonoma	2 lb. bentonite + ⅛ lb. gelatin Filtered with No. 5 pads
Chenin Blanc 1952 St. Helena	2 lb. bentonite + ⅛ lb. gelatin Filtered with No. 5 pads
Folle Blanche 1952 Sonoma	2 lb. bentonite + ⅛ lb. gelatin Filtered with No. 5 pads
Semillon 1952 Sonoma	2 lb. bentonite + ⅛ lb. gelatin Filtered with No. 5 pads
Sauvignon Vert. (No. 1) 1952	1 lb. gelatin plus tannin One filtration
Sauvignon Vert (No. 2) 1952	½ lb. gelatin plus tannin followed by second clarification of 2 lb. bentonite plus a little gelatin plus tannin
Muscat Canelli	14 oz. gelatin plus tannin No filtration

Analyses for total sulfur dioxide and protein were made on portions of each wine sample after filtering through Whatman No. 2 paper. These results are listed in columns 2 and 3 of Table 6. Copper determinations were made on all wines but none showed even a trace. Two hundred and fifty mg. of sulfur dioxide per liter were then added to the filtered wine samples. After bubbling nitrogen through each sample for 10 minutes the bottles were tightly sealed and placed in a 45° C. (113° F.) incubator.

Another portion of each wine was fined with bentonite at the rate of 5 pounds of bentonite per 1000 gallons of wine. The bentonite was added as a 5% suspension to a portion of the wine sample, mixed in a Waring blender for 15 seconds, and then added to the remainder of the sample. Nitrogen was bubbled through each wine for 6 hours but samples were taken at various intervals for protein determinations, the final values of which are given in column 5 of Table 6. Two hundred-fifty mg./l. sulfur dioxide and six mg./l. copper were added to each wine sample. Clear bottles of each were placed in a 45° C. (113° F.) incubator and out-of-doors in direct sunlight. Another series of these bentonite fined wines, containing 6 mg./l. copper and 300 mg./l. sulfur dioxide was placed in brown bottles and stored in direct sunlight.

All the non-bentonite treated wines, except the Folle Blanche and Semillon samples, clouded within 24 hours. The Folle Blanche and Semillon wines were still brilliant after 4 days' storage at 45° C. (113° F.). It is interesting to note that these two wines had the lowest initial protein content of any of the wines tested. After 4 days these two bottles were opened, 6 mg./l. of copper was added, the bottles were resealed and returned to the 45° C. (113° F.) incubator. They remained brilliantly clear even after 5 months of storage. The precipitates that formed in the other wines were irreversible and undoubtedly protein or protein-tannin in nature.

All the bentonite fined wines stored at 45° C. (113° F.) were brilliant after 5 weeks' storage even when they contained 6 mg./l. copper and 300 mg./l. of sulfur dioxide. The duplicate series of these wines stored in the sunlight in clear glass bottles all clouded within 24 hours as indicated in column 7 of Table 6. These clouds were completely reversed upon exposure

TABLE 6

Storage of commercial wines in sunlight and in the dark before and after bentonite treatment

Wine type	Analysis of untreated wine		Before bentonite treatment[1]	After bentonite treatment[2]			
	Total SO_2 mg./l.	Protein mg./l.	Storage in dark at 45° C. (113° F.)	Protein mg./l.	Storage in dark at 45° C. (113° F.)	Storage in sunlight	Storage in sunlight in brown bottle
Sauvignon Vert	Not determined	81	Very cloudy in 24 hrs.	3	Brilliant after 5 wks.	Very cloudy after 2 hrs.	No cloud after 3 days
Semillon	Not determined	41	Very cloudy in 24 hrs.	12	Brilliant after 5 wks.	Very cloudy after 2 hrs.	Green bottle cloudy 2 hrs.
White Pinot, Press	Not determined	29	Very cloudy in 24 hrs.	3	Brilliant after 5 wks.	Cloudy after 2 hrs.	Green bottle cloudy 2 hrs.
Sylvaner	60	27	Very cloudy in 24 hrs.	4	Brilliant after 5 wks.	Cloudy after 24 hrs.	Slight cloud after 2 wks.
Chenin Blanc	53	28	Very cloudy in 24 hrs.	2	Brilliant after 5 wks.	Cloudy after 24 hrs.	Cloudy after 24 hrs.
Semillon	66	6	No cloud after 5 months	4	Brilliant after 5 wks.	Cloudy after 24 hrs.	No cloud after after 5 wks.
Folle Blanche	60	7	No cloud after 5 months	2	Brilliant after 5 wks.	Cloudy after 24 hrs.	Slight cloud after 2 wks.
Sauvignon Vert No. 1	126	48	Very cloudy in 24 hrs.	3	Brilliant after 5 wks.	Very cloudy after 6 hrs.	No cloud after after 5 wks.
Sauvignon Vert No. 2	138	17	Very cloudy in 24 hrs.	2	Brilliant after 5 wks.	Cloudy after 6 hrs.	No cloud after 2 wks. Very slight cloud after 3 wks.
Muscat Canelli	125	19	Very cloudy in 24 hrs.	3	Brilliant after 5 wks.	Cloudy after 6 hrs.	Cloudy after 24 hrs.

[1] 250 mg./l. SO_2 added to each wine. No copper added.
[2] Each wine treated with bentonite at the rate of 5 lb./1000 gal.; then 250 mg./l. SO_2 and 6 mg./l. copper added. Bottled in clear glass except where indicated.

to air. When similar samples were taken from the 45° C. (113° F.) room and placed in the sunlight, they clouded rapidly. It was therefore demonstrated that in spite of high copper and sulfur dioxide contents or wine variety, low protein wines do not form a copper cloud in the absence of sunlight even when stored at high temperatures for long periods of time.

Bentonite fined wines in brown bottles stored in the sunlight clouded much slower than did the same wines in clear glass bottles; certain samples in brown bottles did not cloud at all, even though they contained 6 mg./l.

TABLE 7

Degree of cloudiness in wines stored in the sunlight in brown bottles [1]

Variety of wine	Cloud detection by tyndall beam	Nephelometer reading [2]
Sylvaner	Fair cloud	53
Chenin Blanc	Very heavy cloud	Over 100 Off scale
Sauvignon Vert (No. 1)	No cloud	8.0
Sauvignon Vert (No. 2)	Very faint cloud	11.0
Muscat Canelli	Fair cloud	48
Folle Blanche	Faint cloud	24
Semillon	No cloud	10

[1] These wines were bentonite fined at the rate of 5 pounds per 1000 gallons. Then 6 mg./l. copper and 300 mg./l. sulfur dioxide were added.
[2] All initial readings were zero.

copper and 300 mg./l. sulfur dioxide. (See last column, Table 6.) Sauvignon Vert remained brilliant in brown bottles stored in the sunlight for 3 days but clouded in less than 2 hours when transferred to clear glass bottles.

A Semillon and White Pinot Press wine in green bottles stored in the sunlight clouded as rapidly as when in clear glass bottles. This indicates that radiation of shorter wavelengths is of prime importance in cloud formation.

After 5 weeks' storage in sunlight Nephelometer readings were made on the wines in brown bottles (Table 7). Although all of these samples contained about the same quantities of sulfur dioxide, copper and protein they clouded at different rates. Once the protein is removed by bentonite fining, very little cloud material forms, and large quantities of wine would be necessary in order to obtain sufficient cloud material for analytical purposes. None of the commercial wines used contained sufficient cloud material for isolation or analytical purposes. When a cloud did form, the small amount of material present was very finely divided and remained suspended throughout the wine.

Since all the bentonite fined wines containing 6 mg./l. of copper and 300 mg./l. of sulfur dioxide stored in clear glass bottles in the sunlight clouded within 24 hours, it was of interest to see if these wines would cloud with even more copper but without the additional sulfur dioxide. Seven and one-half mg./l. of copper were added to 100 ml. samples of the bentonite treated wines, filled into clear glass bottles, sealed, and placed in the sunlight. The sulfur dioxide content of these samples is shown in Table 6, column 2. Sauvignon Vert No. 1 clouded within 24 hours and Sauvignon Vert No. 2 in 48 hours, but the others required much longer periods of time. It is of interest that these two Sauvignon Vert samples which contained the highest amounts of sulfur dioxide when obtained from the winery, clouded most rapidly in clear glass even when additional sulfur dioxide was added. On the other hand, when the same two wines were stored in brown glass bottles, they were among the last samples to cloud.

Absorption spectra of glass used in wine bottles. The preceding experiments indicated that sunlight has a pronounced effect on copper cloud formation and that the shorter wavelengths of light appear to be the most harmful. Therefore, sections of glass were cut from clear, green and brown glass bottles and the absorption spectrum of each determined with the view of obtaining an indication of the wavelengths of radiation involved in cloud formation. All the glass sections were approximately the same thickness (4 mm.) and curvature, and all absorption measurements were made on the Beckman DU Spectrophotometer. The results are graphically depicted in Figure 1.

Figure 1 shows that clear glass bottles absorb light strongly only below 350 mμ in wavelength. The green glass sections had two fairly strong absorption bands in the visible region, one between 550 and 800 mμ with a peak at 650 mμ, the other between 400 and 500 mμ with a peak at 450 mμ. Green glass also absorbed all radiations below 350 mμ. Brown glass on the other hand absorbed all light below 500 mμ. Since the wines in clear or green glass bottles clouded very readily whereas those in brown bottles were quite stable, it appears that radiations of 350-500 mμ in wavelength are the most important in copper cloud formation.

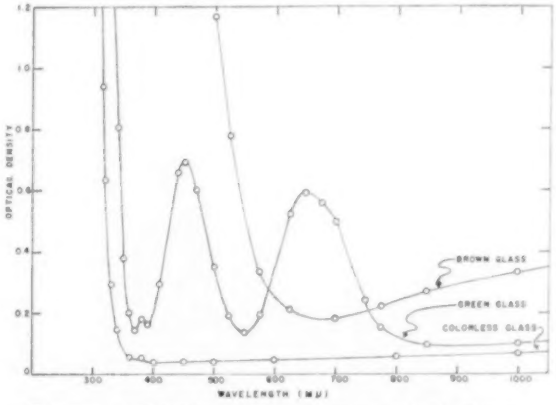

Figure 1. Absorption spectra of various colored glasses.

The chemical effect of light may be any one of the following, or a combination of the following:

a. It may bring about a reaction in a system in which no reaction is taking place.

b. It may catalyze a reaction already under way.

c. It may change the course of a reaction proceeding in the dark with the formation of new products.

Reducing conditions could be produced by the formation of various reducing sulphydryl compounds from the photochemical decomposition of the sulfur-containing substances and by the possible formation of reductone-like substances from the carbohydrates *(4)*.

The literature contains many references to photochemical reactions involving aldehydes, ketones, sugars, proteins and other substances. Abelous *et al. (1)* found formaldehyde among the photochemical decomposition products of sugars. Holtz *(4)* investigated the reaction of other carbohydrate compounds in the ultraviolet, and noted the formation of strongly reducing substances. Eckstein and Lieben *(2)* found that proteins like gelatin and casein split off ammonia under the influence of ultra-violet radiation. The irradiation of egg albumin, according to Wels *(10)*, resulted in the formation of a reducing material giving the reactions characteristic of the sulphydryl group. The decomposition of cysteine and cystine by light was demonstrated by Lieben and Molnar *(7)*. Gray *et al. (3)* showed an increase of sulphydryl compounds in beer with increased exposure to sunlight. They also showed that sulfur dioxide and cystine addition followed by exposure to sunlight also resulted in a rapid increase of sulphydryl compounds. These effects also took place in the dark after considerably longer periods of storage.

Spectrophotometric data relative to the nature of the active radiations in wine are lacking, but Gray *et al. (3)* have done some rather extensive work on beer. Using suitable filters they exposed beer to selected portions of the sun's spectrum. From curves representing the sunlight reaching the beer after passing through the filters and the bottle glass, it was evident that the radiation causing the greatest activity in forming off-odors in beer (attributed to sulfhydryl compounds) was essentially in the blue, violet, or near ultra-violet regions of the spectrum *(3)*. The radiation wavelengths in the yellow, red, or infrared were shown to be relatively inactive. These results parallel those we have found for radiations catalyzing copper cloud formation in wines. It would appear therefore that it should be possible to improve the composition of the glass used for wine bottles in order to provide even greater light protection than is now obtained from the brown or more commonly used green bottles. Increased protection should be obtained from a glass having a spectral transmission curve shifted toward the red end of the spectrum.

DISCUSSION

Bentonite fining caused a marked drop in the protein content of white table wines with subsequent decreased susceptibility to clouding in the presence of heat, copper and sulfur dioxide.

Bentonite effectively reduced the protein content of wines from 50-100 mg. per liter down to 2-10 mg. per liter. The variety of wine, the amount of bentonite added, the method of addition and the time of contact with the wine determines the amount of protein that will be removed by bentonite fining.

Several commercial wines were bentonite fined, followed by an addition of copper and sulfur dioxide. These wines did not cloud in the dark at 45° C. (113° F.) even though they contained relatively high concentrations of copper and sulfur dioxide. Without bentonite fining all these wines rapidly formed irreversible clouds, except for two wines which were extremely low in initial protein content. These same bentonite fined wines formed completely reversible clouds very readily in the sunlight when stored in clear glass bottles. On the other hand, when stored in brown bottles in the sunlight, some did not cloud, and others only slightly and very slowly.

Radiations of 350 mμ to 550 mμ wavelengths appear to be the most active in catalyzing copper clouding.

The presence of copper in a wine does not mean that the wines will cloud, for wines can tolerate relatively high concentrations of copper and sulfur dioxide if the protein content is very low and if the wines are stored in the dark. If wines are stored in the light, they can still tolerate large amounts of copper and sulfur dioxide if the protein content is low and if stored in brown bottles.

SUMMARY

Anaerobic clouding in table wines, including copper clouding, can be greatly reduced or even entirely eliminated by employing the following procedures:

1. Proper bentonite fining to reduce the protein content of the wine to less than 10 mg. per liter.
2. Storage of wines in brown or red bottles.
3. Storage of wines in the dark.
4. Maintaining the sulfur dioxide concentration at the lowest level that good winery practice will permit.

Acknowledgments

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Gas Chromatography—A New Method for The Separation and Identification of Volatile Materials in Foods[a]

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VOLATILE ORGANIC SUBSTANCES in foods and food products, although present in minute amounts, are of great importance since some of them impart the characteristic aroma to the food and, to a large extent, determine its quality. These substances, and other nonvolatile materials which may be converted into volatile compounds by appropriate chemical means, may be analyzed by gas chromatography, provided they can be isolated in a concentrated form from the nonvolatile constituents. The object of this paper is: (a) to present a description of a gas chromatographic apparatus and its operations, and (b) to describe methods for isolating and concentrating these volatiles.

Most flavors involve taste and odor. Taste, the component which we recognize with our tongue, involves four qualities: sweetness, sourness, saltiness, and bitterness. Odor is the other component of flavor. It depends on volatile materials which are detected by our olfactory centers.

Although a considerable amount of work has been done on the mechanism of olfactory perception, essentially it remains a mystery. We do know that this sense is very acute since there are probably no two pure compounds which smell exactly the same. Our sense of smell is extremely sensitive to certain substances—it puts to shame some of the most delicate chemical tests, and, in certain testing work, may fatigue and recover repeatedly during short time intervals. The sense of smell is, however, neither accurately quantitative nor analytical; it is the object of the flavor chemist to reduce such aromas to their individual entities which may then be described.

The volatile flavors of foods are a complex mixture of organic compounds which vary greatly in their amounts, volatility, and flavor intensity. They may be isolated from the food in a variety of ways. The amount of volatile constituents will range from a few p.p.m. to several hundred p.p.m., depending on the food. (One p.p.m. is approximately 1 g./ton.) Unfortunately for the flavor chemist, most of the volatile material is of low flavor intensity, and contributes little, if anything, to the characteristic aroma of the food. Thus, Nelson and Curl *(11)* have reported that the composition of the volatiles from Montmorency cherries is 97% methyl and ethyl alcohols, 3% benzaldehyde, and a trace of geraniol; other substances were present in amounts too small to be determined.

Dimick and Makower *(5)* have found that the volatile flavors of strawberries vary from 25 to 150 p.p.m. and have succeeded in separating the volatile organic materials into a high-boiling, water-insoluble oil of very powerful and characteristic aroma, and a low-boiling fraction virtually without a characteristic aroma and of very low flavor intensity. The amount of the aromatic fractions varied from 2 to 8 p.p.m. Thus, from 100 lbs. of fruit one might expect to obtain from 0.1 to 0.4 g. of this oil.

These findings are not too different from those of other workers who investigated Concord grape juice, wine, pineapple juice, and raspberries. Thus, we may state with fair assurance that an analysis of total volatiles from a food will yield little information in regard to the total flavor of the food.

In the past, analysis of these flavor fractions has been carried out by chemists using distillation techniques on a micro scale followed by chemical analysis. Separations by distillation, even with the most elaborate equipment and pains-taking efforts, usually resulted in only group separations; the higher-boiling materials, which may be the most important flavor-wise, were badly decomposed and poorly resolved. In our own efforts to distill strawberry oil, using a 50-plate, spinning-band column at 5-mm. pressure, separations were so poor and thermal damage so great that this technique was abandoned, and direct chemical analysis of the mixture was attempted. The hopelessness of this attack was evident when this same oil, subjected to a combination of gas chromatographic separations and chemical analyses, revealed the presence of more than 30 individual constituents. Thus, the development of gas chromatography opens the door to the flavor chemist to problems which were heretofore essentially unsolvable.

Separation and analysis by gas chromatography. We recognize two types of gas chromatography: gas-adsorption chromatography and gas-liquid partition chromatography (GLPC). Their counterparts are also used in chromatography involving liquid solvents. In the gas-adsorption chromatography technique, a column is packed with a dry adsorbent such as activated charcoal; a sample is placed on the column and is blown through it by means of a gas stream. The gas stream may be saturated with a more strongly adsorbed material such as nitrobenzene, and separation occurs as a result of differences in adsorption energies. In the gas-liquid partition chromatography technique (GLPC), the column is packed with a stationary phase of size-graded solid particles wet with a liquid of low vapor pressure. The substances are eluted from the column by means of a gas, and separation occurs as a result of differences in vapor pressures over the liquid phase. This latter method is the one initially developed by James and Martin *(9, 10)* in 1952 for the separations of volatile acids and amines, and it is most applicable for the analysis of volatile flavors.

To analyze for the acids or bases as they emerged

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from the column, James and Martin used a continuous titrator. Later, Ray *(14, 15)* developed a more general method, applicable to any volatile material in the gas stream, by using a thermal conductivity cell (katharometer) as the analyzer. Differences in voltage were detected by a pen recorder which plotted, as a peak, each substance as it emerged from the column.

Gas chromatography really represents a superlative fractionating column. With the apparatus to be described, the authors have been able to separate completely two esters differing by only 3° C. (5.4° F.) in boiling point. Using this technique, the separation was accomplished in 10 minutes on a 4 mg. sample. By means of a special collecting device, near quantitative recoveries were made of materials boiling as low as 27° C. (80.6° F.). The pen recorder makes a permanent record of the emergence of each substance; the area of the peak is proportional to the molar quantity of the substance. The boiling point of type substances is proportional to the logarithm of the time required for the peak to appear (residence time) after injection of the sample. Thus, a close estimate of the boiling point of an unknown may be made from a calibration curve made from known materials.

The resolving power of this apparatus is very high. Using an 11-ft. column, ¼ in. in diameter, packed with a Celite-silicone-stearic acid mixture, James and Martin estimated the efficiency of the column at approximately 2,000 theoretical plates. In addition to its speed and phenomenal plate efficiency, this method of separating volatile substances has a great advantage over distillation in that the type of stationary phase may be changed by packing a new column which, in effect, gives a situation analogous to two-dimensional paper chromatography. The two liquids, water and methanol, appear as a single substance when subjected to separation by the silicone column, but when placed on a column of Celite and Carbowax, this mixture gave clean resolution.

A further point should be emphasized: materials of different types, such as alcohol and esters, may be readily separated, although their boiling points may be almost identical. As an example, ethanol and ethyl acetate are separated on either the silicone or the Carbowax column, and their boiling points differ by approximately one degree. A final great attribute of the method is the absence of any tendency to form azeotropes.

APPARATUS AND OPERATION

In Figure 1 is shown a working drawing of the thermal conductivity cell as well as details of the injection system, and collection tube. [A material list is also provided (Figure 1) referring to the various components.] In Figure 2 is given a projection drawing of the completed apparatus.

From Figure 1 it is seen that the eluting gas stream, helium (at a flow rate of approximately 40 ml./min.), enters the side of the cell block at (8), contacts filament (a) by diffusion, and leaves the block on the opposite side. (This filament is one leg of a Wheatstone bridge as shown in Figure 3.) The helium stream is then conducted to the injector tube (2) through a ¼-in. copper tubing and plastic tube connection. The sample to be analyzed is injected through a serum bottle cap (1) by means of a suitable hypodermic needle. The sample flows directly onto the column with the helium stream.

Separation of components is made during their movement through the column. As each separated component flows over filament (b) the dilution of the helium stream causes less cooling of this filament and a corresponding increase in resistance. Filament (b) is another leg of the Wheatstone bridge. The unbalance of the bridge is indicated by an electronic pen recorder plotting voltage against time. The extent of unbalance is approximately proportional to the molar amount of material and, thus, is proportional to the area under the peak described by the recorder. The gas stream then emerges from the apparatus at (12), and any organic material may be condensed out by means of the glass adapter and centrifuge tube combination.

Cell geometry and bridge circuit. As Patton, Lewis, and Kaye *(12)* point out, it is important, from the standpoint of a strong signal output and rapid response time, that the gas flows directly over the detector filament rather than to depend on diffusion. We have not observed an objectionable flow sensitivity by this method even at highest sensitivity.

The bridge circuit and controls, as shown in Figure 3, consists of a coarse (1) and fine (2) zero adjustment; two coiled, tungsten filaments, type M/TT (Gow-Mac

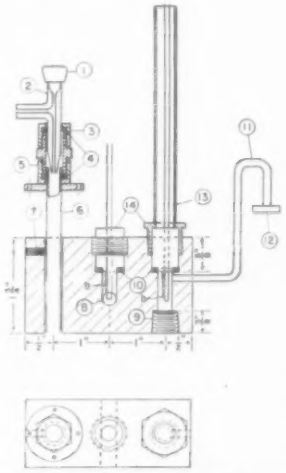

Figure 1. Detailed working drawing of thermal conductivity cell with injection device, collecting tube, and filaments. See material list for details.

Material List

1. Serum bottle cap, rubber, small
2. Glass injecting capillary, 1-mm.
3. Nut, compression fitting, ¼-in.
4. Gasket, silicone rubber, ⅛-in.
5. Nut, compression fitting, brazed to 1 in. x ⅛-in. mounting plate
6. Column, ¼-in. metal tubing
7. Locking screw to secure tubing
8. Helium inlet, ¼-in. copper tube brazed
9. Column attachment, ¼-in. compression to ⅛-in. pipe
10. Gasket, silicone rubber, 1/16-in.
11. Exit tube, ⅛-in. tubing (for high-boiling materials, this must be heated with a nichrome heating element)
12. Post joint, brass; this is an extremely flat connection. The glass Post contact joints were obtained from H. O. Post, 6822-60th Road, Maspeth, New York
13. Filament compression caps with welded ⅛-in. x 4-in. threaded extension tube (5/64-in., 24 threads)
14. Filaments, Gow-Mac, type M/TT

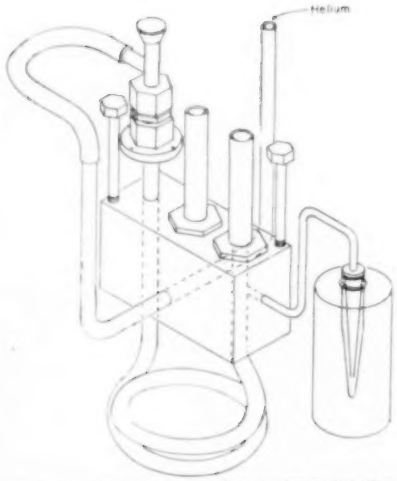

Figure 2. Projection drawing of assembled GLPC unit showing thermal conductivity cell, column, injection device and collection tube.

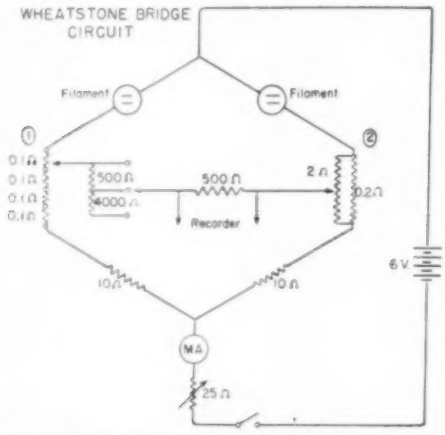

Figure 3. Wheatstone bridge circuit with coarse (1) and fine (2) zero adjustment, and voltage divider for sensitivity selection.

Instrument Co., Madison, New Jersey),[b] approximately 20 ohms; two fixed, 10-ohm resistors; a voltage divider permitting a range of sensitivity of 2, 4, and 20 mv. full-scale deflection on the recorder; a milliammeter of 0 to 300 ma. range; a 25-ohm variable resistor; a strip chart, electronic pen recorder with a sensitivity of 2 mv. full-scale deflection, and a full-scale pen speed of 4½ sec.

The filaments operate at a current of 138 ma. With this current, the temperature of the filament wire is approximately 100° C. above ambient. Since the filaments are thermally sensitive, it is necessary to shield the brass extension tubes (13) above the lid from air currents (Figure 1).

Injection and collection. The injection system shown in Figures 1 and 2 was arranged so that a sample could be placed directly onto the column at approximately the same temperature as that of the bath. As discussed by Pollard and Hardy *(13)*, a high injection temperature is important in the interest of obtaining maximum plate efficiency. The injection also is made in front of the gas stream to insure a complete and rapid transfer of material to the column. The glass injector tube serves as a thermal insulator which protects the rubber serum bottle cap.

Material with a boiling point as low as 27° C. can be condensed almost quantitatively with this collection device using Dry Ice-ethanol as the coolant. In some instances, the formation of noncondensable fogs will give lowered recoveries. Recoveries of greater than 90% were made when 40 microliters of isopentane, methanol, and ethanol were injected. A sample change is made, when the recorder returns to a minimum value, by removing both the glass adapter and tube and replacing them with clean parts. The tube and adapter are centrifuged for about 2 minutes, an action which causes the fraction to collect in the centrifuge tube. A sample change requires about 10 seconds.

Column packing. In the interest of compactness, we found that use of a coiled tube served very well as a column. Packing material was prepared as described by James and Martin by mixing, by weight, 2 parts of size-graded Celite with one part oil *(9)*. A selected length of ¼-in. copper or stainless steel tubing is clamped in a vertical position, plugged at the bottom with glass wool, and attached to a vacuum source. As the tubing was vibrated by a hand-massage vibrator, the packing material was fed into the upper end of the tube through a glass funnel. When further settling of the packing could not be detected, the column was wound on a mandrel and attached to the rest of the apparatus. A column of a length greater than 10 ft. has not appeared essential for most work. Although the plate efficiency is greater for a longer column, the increase in pressure drop and residence time imposes a practical limit on the length.

EXPERIMENTAL

The choice of the stationary phase (substrate) used in the column packing is of utmost importance. The substrate should have a very low-vapor pressure at elevated temperatures and be stable thermally. We have found a silicone oil, G.E. SF96-40, and a Carbowax "1500" Union Carbide and Carbon, to be most practical. They complement each other ideally in separations involving heterogeneous types of materials. Table 1 shows the relative time for ethyl alcohol, ethyl acetate, methyl ethyl ketone, *n*-heptane, benzene, and water to move through 10-ft. columns of silicone and Carbowax. The temperature of the column was 150° C., and the helium flow rate was 62 ml./min. The 2 pairs, water-ethanol and ethyl acetate-methyl ethyl ketone, were not resolved on the silicone column but could be resolved on the Carbowax column. The great difference in the characteristics of both columns is shown by the residence times of water and *n*-heptane, whereas benzene appears to have approximately the same vapor pressure relationships with each column.

The Carbowax column also appears to have the ability to separate unsaturated compounds from the

[b] It is to be understood that the products of these companies are not recommended over those of any others engaged in the same business, but their names are furnished for the convenience and information of those interested.

TABLE 1

Residence times for Carbowax and Silicone columns

Compound	Boiling point °C.	Residence time			
		Silicone[1]		Carbowax[1]	
		Min.	Sec.	Min.	Sec.
Ethyl Acetate	72.2	4	20	5	20
Ethyl Alcohol	78.3	1	30	8	0
Methyl Ethyl Ketone	80	4	40	6	0
Benzene	80	7	10	7	0
n-Heptane	98	10	20	1	30
Water	100.0	1	40	17	0

[1] Column temperature, 150° C.; helium flow rate, 62 ml./min.; column length, 10 ft.

saturated, which may be unresolved by the silicone column. In strawberry oil *(3)*, for example, we found the pair, *n*-hexanol and *trans*-2-hexenol-1, to be unresolved by the silicone column. On a 5-ft. Carbowax column, however, this pair was resolved completely. Samples were collected and identified by infrared spectra and melting points of appropriate derivatives.

Calibration curves were prepared from known alcohols and ethyl esters, for both columns at various bath temperatures, by plotting the boiling points of each substance against the logarithm of the residence time. In Figures 4 and 5 are shown typical separations of *n*-alcohols and ethyl esters on a 10-ft. silicone column at a bath temperature of 150° C.; the helium flow rate was 42 ml./min. In Figure 6 are shown the calibration curves made from these data. A close approximation of the boiling point of an unknown may be made from these curves if the unknown is an alcohol or an ester. By submitting the compound to analysis on both the Carbowax and silicone columns and noting the relative residence times (as shown in Table 1), its type is revealed approximately.

Volatile Flavor Separation and Concentration

Distillation and extraction. Probably the most common means of separating the volatiles from food is by some form of distillation. Our own work on the recovery and concentration of volatile strawberry flavor will illustrate the approach *(3)*.

The fruit is first transformed into a puree which is pumped into a vacuum flash-evaporator *(4)*. Approximately 40% of the water is removed by evaporation at a temperature of 38° C. (100° F.). The water vapor and the volatile flavors are condensed by ice water and Dry Ice traps which precede the vacuum source. Thus, it is possible to separate the flavors from the heat-sensitive fruit solids, at high speed and low temperature, and a minimum of so-called "heat-generated flavors" are formed.

It should be emphasized at this point that all of the flavors will not be recovered. Tests have shown that the low-boiling materials (below 100° C.) will be distilled over, almost quantitatively, with the water vapor. The high-boiling substances, boiling up to 280° C., are another matter. Almost always, these substances will be only partially soluble in water, and, therefore, will form heterogeneous azeotropes. As such, they will distill over with water since the azeotrope boils below the temperature of water. Such azeotropes, however, generally boil only slightly below the temperature of water, and good recovery cannot be expected using a system of

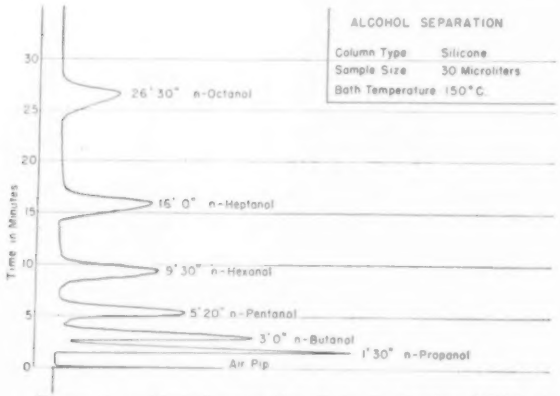

Figure 4. n-Alcohol separation C_1 to C_8 showing initial air pip and retention times for alcohol peaks. Silicone column (length 10 ft.), gas flow 62 ml./min., bath temperature 150° C., sensitivity 20 mv. full scale.

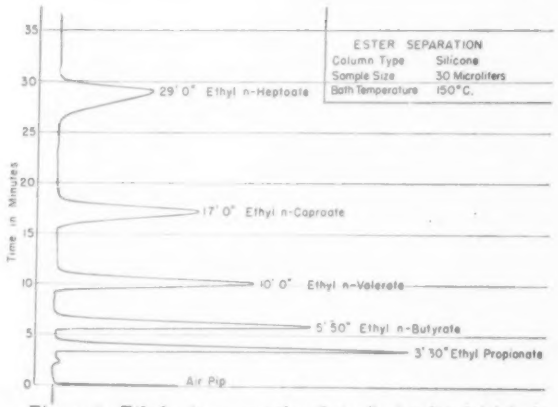

Figure 5. Ethyl ester separation C_3 to C_8 showing initial air pip, trace of water, and retention times for ester peaks. Same conditions as in Figure 4.

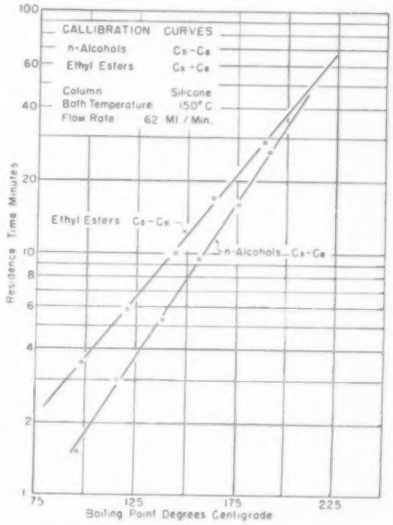

Figure 6. Calibration curves for n-alcohols and ethyl esters from Figures 4 and 5 plotting log of retention times vs. boiling point of compound.

low plate efficiencies such as a flash evaporator. Tests conducted by the authors *(4, 5)* using phenol, which forms an azeotrope boiling at 99.6° C., showed that the flash evaporator was incapable of concentrating the phenol, and recovery was only as great as the percentage of water evaporated. Thus, expected recoveries of the high-boiling flavoring substances may not be significantly higher than the percentage of water removed.

With this in mind, a high-plate efficiency, continuous-feed, distillation column *(6)* was designed for the concentration of the dilute aqueous flavor solution obtained from the flash evaporator. With this still, a concentration of phenol or strawberry essence to many hundred-fold could be achieved without appreciable loss.

The final step in removing the volatile flavors from the concentrated aqueous flavor solution was a liquid-liquid continuous extraction with isopentane. The choice of this solvent was fortunate, not only because of its low boiling temperature (which facilitates its subsequent removal from the volatile flavor fraction) but also because it will not extract ethyl alcohol from a water solution. This then solves the problem of separating the large amount of ethanol usually occurring in the volatile food flavors from the remaining components. Removal of the isopentane by distillation is a simple matter, and the product is ready for separation by gas chromatography.

Other concentration procedures are used and will be described briefly. Ether extraction is very often employed in final extractive steps such as removal of flavors from concentrated aqueous solutions or from charcoal on which the substances have been adsorbed. Coppens and Hoejenbos employed direct ether extraction for separating the volatiles from strawberry juice *(1)* and raspberry juice *(2)*. These workers were able to identify many of the flavor components in this way; however, extracted waxes from the juices were difficult to manage.

By using activated charcoal to adsorb the emanations from apples in a storage plant, R. E. Henze *(8)* was able to recover several pounds of water-free essence by ether extraction of charcoal. The volatiles from onions and garlic have been accumulated in substantial amounts at a dehydration plant *(7)* by this same procedure.

Sweeping the food with a gas stream and recovery of the volatiles from the gas by condensing with Dry Ice or liquid air is a popular method for flavor recovery because of its simplicity and lack of thermal damage to the food. Adrienne Thomson *(18)* has carried out considerable work on the volatile substances in apples. She collected the volatiles in the manner mentioned and separated them from any water by ether extraction. Reichstein and Staudinger *(15)* report an effective concentration of coffee flavor by vacuum distillation of roasted, dry coffee. More than 70 substances were reported to be separated and identified from a very heat-labile, yellow oil obtained in this way.

Many flavors from plant materials such as mint, citrus peel, lavender, flowers, leaves, etc., may be collected by steam distillation. These essential oils are generally in such abundant proportions and low solubility that they can be collected merely by separating them from the water distillate. These materials, used in soaps, perfumes, cosmetics, etc., are not generally considered as part of food flavors, although some citrus oils pressed from the peel are being used for restoring flavor to citrus juice concentrates *(17)*.

Acknowledgment

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The Ascorbic Acid Content of Sauerkraut*

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(Manuscript received April 11, 1956)

DURING THE FERMENTATION of sauerkraut, the acids and carbon dioxide produced not only protect the product from the growth of undesirable bacteria, but also produce a low oxygen tension, favorable to ascorbic acid stability. Pederson, Mack, and Athawes *(2)* showed that ascorbic acid was retained during fermentation but decreased after active fermentation was completed. They found that 53 samples of raw kraut approximately one month old contained 5 to 51 mg. of ascorbic acid and averaged 31 mg. whereas older kraut held 7 months or longer, averaged only 10.3 mg. Similar results were obtained with canned kraut. Pederson and Robinson *(3)* observed losses of ascorbic acid in canned kraut during storage which were attributable to temperature of storage.

In a previous report *(1)*, it was noted that the quality of sauerkraut is influenced to a large extent by the salt-acid ratio. Analyses for ascorbic acid were made on many of the samples of kraut used in that study as well as on many samples of known history obtained in studies of temperature effects.

Methods of analysis are those described in a previous report *(3)*.

SURVEY OF COMMERCIAL KRAUT

The 217 samples of canned kraut were graded in 1953, 1954, and 1955, by members of the National Kraut Packers' Association and representatives of the Fruit and Vegetable Processed Foods Branch, U.S.D.A.

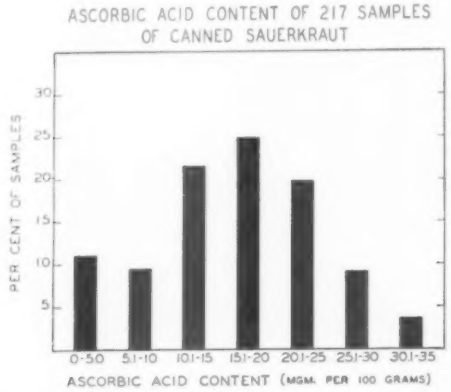

Figure 1. Ascorbic acid content of 217 samples of canned sauerkraut.

Of these, 3.7% contained more than 30 mg. of ascorbic acid per 100 g. (Figure 1), 57.6% of the samples showed a content above 15 mg. and 11.1% contained 5 mg. or less.

A general relationship exists between the quality ratings accorded these samples and their ascorbic acid contents. Correlation between the total scores and the ascorbic acid, although low, was statistically significant ($r = 0.26$). For example, of the 11 samples in 1955 containing less than 10 mg. of ascorbic acid, 5 were rated below 85 in quality score, while among the 50 samples containing 15 mg. or more only 8 rated below 85. Several samples, however, were given a poor score although they contained a high amount of ascorbic acid. Such krauts may have been inferior in other respects such as greenness, high salt-acid ratio, or off-odor, defects which do not necessarily affect the ascorbic acid content. The great variation in content of ascorbic acid is not surprising. Such variations may be attributed to initial ascorbic acid content of the raw cabbage or certain differences in handling.

EFFECT OF TEMPERATURE AND STORAGE BEFORE CANNING UPON ASCORBIC ACID

Sauerkraut is packed under a variety of conditions. Most kraut is produced in the Northern states and in the fall of the year. Temperatures throughout the season are most variable. In 1953, average daily temperatures in New York State ranged from 24° F. to 85° F. during the cutting season. The temperature of the cabbage when it is brought into the factory will be about the same as the air temperature in the field from which it is obtained. Since this cabbage is stored in bins for a day or two in a large mass, temperatures will not change much. Cabbage temperature, particularly after shredding, will tend to approach working room temperatures. If cold cabbage is taken to a heated factory, a rise of several degrees may occur in the cabbage during trimming, shredding and packing. After packing in a vat, temperature changes are very slow. An average of only 1° F. change was noted during a 3-day period among several vats studied in 1953.

In order to determine whether any of these differences in handling of cabbage and sauerkraut may affect the retention of ascorbic acid, a study was made of krauts canned from vats of known history. Available were fairly accurate records of filling time and temperature, rate of fermentation, and time of canning. This study comprised 71 tanks of kraut of the 1953 and 1954 seasons. In addition a number of samples were analyzed from tanks, the history of which were less complete. Samples of canned kraut from many of these vats were analyzed for total acid, salt, and ascorbic acid. A comparison of the results with other pertinent data reveals some of the reasons for differences in ascorbic acid among canned krauts.

The ascorbic acid content of canned sauerkraut was was found to be influenced by the length of time in storage before canning, the cabbage temperature at the

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time of filling the vats, and the temperature of vat rooms.

Among the 71 vats canned from 3 to 97 weeks after filling, ascorbic acid of the canned krauts varied from 0.2 to 32.0 mg. per 100 g. (Table 1). Analysis of these

TABLE 1

Comparison of ascorbic acid and age of kraut when canned

Age of kraut when canned	Ascorbic acid	Age of kraut when canned	Ascorbic acid	Age of kraut when canned	Ascorbic acid
weeks	*mg./100 g.*	*weeks*	*mg./100 g.*	*weeks*	*mg./100 g.*
3	12.4	8	32.0	32	11.1
4	20.9	8	18.4	33	0.2
4	15.8	8	13.7	36	8.1
4	15.6	8	7.6	37	13.6
4	12.2	9	20.0	37	3.9
4	11.1	9	5.4	38	10.7
4	10.8	10	20.0	39	10.9
4	3.8	10	19.9	40	6.7
4	2.2	10	2.1	40	4.6
5	25.2	11	2.8	40	4.6
5	20.4	14	8.0	40	2.1
5	22.0	22	13.6	40	1.9
5	12.1	24	4.8	40	1.3
6	29.9	25	2.8	40	0.6
6	21.4	28	9.4	45	14.4
6	13.9	29	12.8	45	10.3
6	10.6	29	1.0	46	6.9
6	2.4	30	4.5	48	1.5
7	32.0	30	11.9	49	4.3
7	23.0	30	17.8	60	11.3
7	9.4	31	12.6	60	10.6
7	4.0	31	0.5	60	10.6
7	3.8	32	13.2	97	2.4
7	2.2	32	12.6		

data reveals a general relationship between ascorbic acid content and age of the kraut when canned. Thus, those canned when 3 to 10 weeks old averaged 14.4 mg., those canned when 22 to 40 weeks old averaged 8.8 mg., and those canned when 40 to 49 weeks old averaged 4.9 mg. of ascorbic acid. The variation in ascorbic acid between samples of the same age when canned is partially due to the temperature.

Specific temperatures of the fermenting krauts were impossible to obtain since they are affected by the temperatures of the storage room and the cabbage when cut. Variations occur within different parts of the vats. However, selecting a few examples, relationships may be noted. Four of the vats of kraut canned between 3 and 10 weeks were known to have averaged over 65° F. They yielded 10.8, 3.8, 3.8 and 12.1 mg. of ascorbic acid. In contrast, one tank, averaging between 37 and 40° F., contained 20.0 mg. after 10 weeks. Similarly the 5 vats filled between 55 and 70° F. and held 22 and 40 weeks yielded 2.8, 4.5, 0.5, 0.2 and 3.9 mg. of ascorbic acid, considerably below the average; in contrast the 6 vats in this age group filled at about 40° F. yielded 13.6, 4.8, 12.8, 1.0, 13.6 and 10.7 mg. The two samples in the next age group, 40 to 49 weeks, that yielded 14.4 and 10.3 mg. were packed when the temperature was well below 40° F. The other samples were packed in warmer weather (Table 1).

Other series only partially reported in Table 1 because of insufficient temperature information include a series of samples obtained in 1953 from factories maintaining nearly ideal temperature conditions for workers, that is near 70° F. Except for the krauts canned within a short time after completion of fermentation, ascorbic acid contents were low. Thus one series which had fermented rapidly was canned 5, 6, 4, 4, 3, 4 and 6 weeks after packing and yielded 20.4, 21.4, 15.6, 12.2, 12.4, 11.1 and 5.0 mg. ascorbic acid, respectively. A second series was held 3 months or more before canning. They showed the low values of 5.4, 2.2, 3.8, 9.4, 2.4, 2.3 and 10.6 mg. The last sample was obtained from a vat packed on the coldest day of the month. Another vat packed on this same day but canned still later yielded 12.1 mg. A third series of 4 vats canned after 5 months yielded only 4.8, 2.8, 8.0 and 2.8 mg. of ascorbic acid.

In 1953 four vats filled within 5 days, all at a uniform temperature of 60 and 65° F. were canned 5, 6, 11 and 14 weeks later. They showed 21.4, 20.4, 10.8 and 3.8 mg. of ascorbic acid, a progressive decrease with increasing storage time. Four other tanks packed within a 3-day period and canned after 39, 43, 46 and 216 days, showed a similar decrease with storage time yielding 12.2, 12.4, 11.0, and 0.5 mg., ascorbic acid, respectively. Among 5 tanks held until June, 1954, to demonstrate the effect of temperature of filling upon ascorbic acid content, two tanks, filled when the weather was warm, contained only 0.2 and 0.5 mg., of ascorbic acid. The other three, packed in the cold weather of November 5 and 6, and December 16, contained 13.6, 1.0, and 13.6 mg., respectively. The low figure of 1.0 mg., is the only marked exception to the results obtained. For this particular sample, the cabbage used was extremely cold and many outside leaves frozen when trimmed. Fermentation proceeded very slowly and the quality of the canned kraut was poor. It is suspected that a faulty early fermentation occurred. A slow fermentation would delay the development of low oxygen tension, and thus allow early oxidation of ascorbic acid.

Comparisons of average daily temperatures for 1954 with the ascorbic acid contents of cans of kraut from 16 vats in one factory (Figure 2) demonstrate the effect of temperature. With one exception (dotted line), all of these krauts were canned from 249 to 340 days after filling the vats. Note the low ascorbic acid values,

TABLE 2

Destruction of ascorbic acid in processed sauerkraut during storage at different temperatures

Storage temperature	Storage time	Ascorbic acid
° F.	*days*	*mg./100 g.*
34	53	19.3
34	159	15.8
45	53	19.6
45	159	16.1
65	53	16.3
65	159	14.8
89	53	13.1
89	159	12.1
98	53	15.6
98	159	11.6
110	42	12.1
110	53	11.4
110	159	5.3
130	1	13.2
130	8	4.6

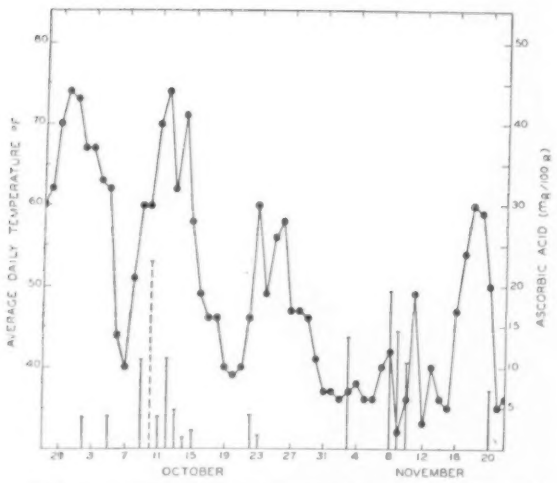

Figure 2. Comparison of average daily temperature with the ascorbic acid content of kraut from 14 vats.

Vertical lines represent the ascorbic acid content in kraut from the tanks packed on the designated dates. Broken vertical line from another factory.

Figure 2, of kraut packed on October 2, 5, 11, 13, 14 and 15, 22 and 23, as compared with the higher values of krauts packed after the cold weather of October 7 and 9 and November 3 to 10. The latter high values were followed by a lower value for kraut packed following the next warm weather, November 18th. In part, an inverse relationship between daily air temperature on the day previous to filling the vats and the ascorbic acid content was observed. The low values observed for kraut packed on October 22 and 23 are apparently contrary to the usual results. Possibly, if more information were available, they could be explained.

Effects of length of storage time before canning upon ascorbic acid retention are shown in the early October, 1954 group (Figure 2). With one exception these krauts were canned from 8 to 9 months after filling the vats. The one exception, a vat of kraut canned 60 days after filling (Figure 2, dotted line), contained 23 mg., of ascorbic acid, i.e., more than twice the values of the krauts held for the longer periods. Another vat of kraut in this factory, cut 3 weeks earlier, but canned when 65 days old, contained 18.4 mg.

RETENTION OF ASCORBIC ACID IN CANNED SAUERKRAUT

To study the retention of ascorbic acid in processed kraut during storage it is essential to follow a specific lot of kraut from start to finish. A number of glass jars packed from a single lot of kraut were divided for storage at 7 temperatures, 34°, 45°, 65°, 89°, 98°, 110°, and 130° F. The original kraut contained 19.3 mg. of ascorbic acid. After storage at 130° F. for one and 8 days, only 13.2 and 4.6 mg. were retained; therefore, losses were 31 and 76%. Ascorbic acid retention was somewhat better at 110° F., but amounts were reduced after 42, 53, and 159 days to 12.1, 10.4, and 5.3 mg., representing losses of 37, 41, and 72%, respectively. Losses at 98°, 89°, 65°, and 45° F., were increasingly smaller, so that after 159 days storage losses of 40, 37, 23, and 16%, respectively, were observed.

SUMMARY

Analysis for ascorbic acid has been made upon 217 cans of sauerkraut graded by experts as well as a number of samples from vats of kraut of known history.

The 217 canned krauts yielded ascorbic acid contents from 35 mg. down to less than 1.0 mg. per 100 g.

The evidence on the ascorbic acid values of kraut canned from vats of known histories indicates that temperature of filling vats and storage time in vats have a marked influence upon the ascorbic acid content.

Similarly, temperature and storage time of canned krauts are important factors in determining retention of ascorbic acid.

Obviously, a pack of sauerkraut with a higher average and more uniform ascorbic acid content could be attained if more attention were given by the packers to temperature and time effects.

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Factors Affecting the Retention of Red Color in Peppers[a]

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PAPRIKA AND CAYENNE PEPPERS are harvested within a few months' time in the United States. Since it may be many months before the dried ground product reaches the homemaker, the problem of loss of red color during the necessary storage period is one of importance.

The pigments present in paprika have been investigated by Zechmeister and Cholnoky in a series of papers. The main pigment was found to be "capsicum red," a mixture of esters of capsanthin, capsorubin, zeaxanthin, cryptoxanthin, and other carotenoids; β-carotene contributed to the color to a lesser extent. A small percentage of these carotenoids in non-esterified form was also found. A brief summary of this work is given by Cholnoky *(2)*.

Cholnoky *(2)* in discussing Hungarian paprika, which may include as many as five harvests, stated that the first picking was considered to be the most valuable. On analyzing several varieties of paprikas for two yearly harvests, he found that with one exception, the total color was higher for the first harvest than for the second. Capsorubin and capsanthin, whose esters were the main source of red color, were present in the greatest amount in the first harvest. Carotene and cryptoxanthin content increased in the second harvest. The 8% color loss noted over a 12-month storage period was distributed among the various carotenoids.

Brown *(1)* showed the pigment of "Perfection" pimiento to be capsanthin. Georgia workers *(3)* found that the carotenoid pigments of dried pimientos were destroyed "rather easily" by oxidation. This could be prevented, in part, by storage at 40-50° F. in H_2S or by addition of ascorbic acid, or by a combination of both, but not by storage in hydrogen.

Van Blaricom and Martin *(11)* found considerable variation in color retention with different lots of pepper on aging. Treatment of the raw pod pepper in various ways before drying did not retard subsquent color loss. The type of container in which the dried pepper was stored did not affect color loss *(10)*. The location in which the pepper was grown, or the kind of fertilizer used could not be correlated with differences in color stability *(11)*. No relation between rainfall during the growing season and color stability was found *(7)*. Several suggestions as to the cause of differences in color stability were offered. In the present paper these factors along with others were investigated, using several varieties of *Capsicum frutescens*, in an attempt to determine which factors were most significant in causing discoloration. Their identification would indicate ways in which discoloration could be minimized and also might serve as a quick test to determine, at the time of harvest, which strain of pepper would readily discolor.

[a] Technical Contribution No. 225 from the South Carolina Agricultural Experiment Station, Clemson.

EXPERIMENTAL

The varieties of peppers tested were grown by the Horticulture Department of the South Carolina Agricultural Experiment Station at Clemson during the years 1950 through 1955, inclusive. The varieties included Louisiana sports, long cayenne 69A, Hontanka, P. I. 159-263, P. I. 194-881, Jalapino, "Seedless" cayenne (a sterile type) and "stock," a mixture of various strains of cayenne 69A of the 1950 crop. "Seeded" cayenne was cayenne 69A with the seeds removed before grinding. The paprikas included Carolina 7, 1-M-1, and 1-G-6. A number of strains of cayenne pepper for the 1952, 1953, and 1954 harvests were also tested. Ground paprika imported from Spain,[b] grown in 1951 and 1952, was used.

The whole peppers with the stem end removed were dried at 100-120° F. and ground to a fine powder. Care was taken to assure that only pods free from disease and other defects were selected. The peppers were grown from seed stocks maintained by the Horticultural Department, at one location, and had the same cultural treatment.

In the Pee Dee area of South Carolina, pepper growers follow the practice of picking at one time all peppers which are fully colored, and following this practice until frost stops the picking. This "field run" of the crop was used unless otherwise designated.

Since some peppers showed color loss by fading so as to appear bleached, while others showed color loss by turning brown, a comparison of the solid peppers was not feasible.

Ethanol solutions of peppers are widely used in the pepper industry as a basis for color comparison *(8)*. These solutions were not used in this study for several reasons. The main pigments of paprika are carotenoid esters which are readily soluble in petroleum ether but are much less soluble in ethanol *(4, 5)*. It was necessary to take a comparatively large aliquot of the aged pepper in order to get a representative sample. Furthermore, ethanol solutions are not suitable for chromatography. After extraction, the residual pigments of the discolored pepper were very unstable under the further manipulation necessary when ethanol is used. Hexane, a widely used carotenoid solvent, was found to remove the color from the peppers readily, with little extraneous matter. The pigments of the peppers were found to be very stable in hexane, 90 to 100% being retained at 25° C. for 12 months, irrespective of the comparative color stabilities of the original solid varieties. Only when the peppers were at least 70% discolored did their hexane extracts subsequently lose color and then only slowly. Loss of color as indicated by the hexane extracts followed the loss of color of the peppers as determined visually.

One-gram representative samples of the dry ground pepper were shaken with three successive 75 ml. portions of hexane over a 24-hour period in a mechanical shaker. The last portion of hexane was colorless or only faintly colored. The combined extracts were made up to 250 ml. and an aliquot taken for the colorimetric reading. A one ml. aliquot diluted to 10 ml. with hexane gave a range suitable for most of the peppers as received. As discoloration proceeded, the aliquot was increased. For very faded peppers, an aliquot of 10 ml. with no dilution was necessary. Comparison was made to 1 N potassium dichromate solution in an Evelyn photoelectric colorimeter with a filter of 410-474 mμ range. Capsanthin, capsorubin and zeaxanthin, and their esters so far as they are known, have their strongest absorption maxima in hexane in the upper part of this filter range *(4)*. In preliminary chromatographic studies, the greatest absorption of the pigments of the newly harvested pepper and paprika, after the ester linkage was broken, was found in this range. Some of the pigments of peppers discolored by aging or other treatments exhibited absorption maxima which cor-

[b] Supplied by The McCormick Company, Baltimore, Md.

responded to the lower ranges of this filter. Proportions of these pigments would be changing as the pepper aged; thus a wide filter range was chosen.

The amount of free xanthophylls, esterified xanthophylls, carotene-nonsaponifiable matter and β-carotene in the hexane extracts of the new and of the aged pepper from some samples was determined. The general method for separation between 90% methanol and hexane, into an epiphasic layer containing the carotenes and xanthophyll esters and a hypophasic layer containing the free anthophylls was employed *(9)*. The esters were subsequently saponified and similarly separated from the carotenes. Details for the saponification of the pigment waxes of pepper are given by Zechmeister *(5)*. After chromatography, β-carotene was identified by its absorption spectrum with a Beckman DU spectrophotometer.

The samples were kept on a shelf in the laboratory, out of direct sunlight at room temperature (circa 25° C.) in a refrigerator (circa 5° C.); and in an incubator at 37° C. Samples were taken of the more color-stable peppers at 30-day intervals; of the color unstable peppers, at 7-day intervals.

Moisture content was determined by heating at 100° C. for 16 hours; the crude fat content by continuous hot extraction with ethyl ether for 16 hours.

Variations in initial color concentration, moisture and fat content, and color stability were found with the same varieties from year to year. Therefore, results given in the tables and graphs include any one year's harvest. These were confirmed by at least one other year's harvest.

RESULTS

The percentage color retention of some of the varieties on aging is shown in Figure 1. S indicates paprika which was harvested when the pods were fully colored but still succulent. D indicates paprika which was harvested after the pods had stayed on the plant until they were shriveled and dried. Although exact percentage retention varied from year to year, this same general relation of one variety to another was maintained.

Initial composition of peppers in relation to loss of color on aging. The varieties tested provided a wide range in initial color concentration, in moisture and crude fat content, and in color stability. The intensity of the initial color was not correlated with the ability of the peppers to resist discoloration on aging. Similarly the percentage of moisture or of crude fat was not correlated with subsequent color stability (Table 1). Similar lack of correlation was found for the extremes in color stability of a series of 80 strains of the same variety of cayenne pepper (Table 2).

Whereas high fat content may be associated with high color stability in some samples, it is not an indication as such of the ability of a strain of pepper to retain its color. Within either the group showing highest color retention, or that showing lowest percentage color retention, the percentage of crude fat was not correlated with color stability. Furthermore, strains with the same crude fat content could have a difference in color retention of 50% for the same period of storage.

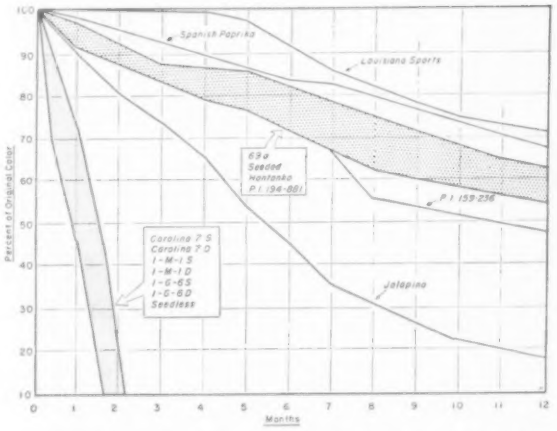

Figure 1. Loss of color of different varieties on aging in bottles at 25° C.

Fractions of pepper pigment. The ester fraction comprised by far the major part of the color (Table 3). There was no correlation between the initial concentration of any one of the four pigment classifications and color stability on aging. Separation of the pigment fractions after aging was complicated by the general instability of the pigment of the aged peppers to any treatment, evidenced here by a failure to recover 100% of the color in the several classifications. Taking this into account, it can be said that no one classification disappeared entirely at the stage of aging at which these samples were taken.

TABLE 1

Color stability of varieties of peppers as related to initial color, moisture and crude fat content

Variety	Initial color	Moisture	Crude fat	Color retention after 6 months at 25° C.
	$K_2Cr_2O_7$ equivalents	%	%	%
Louisiana sports	.386	6.4	17.7	78
Cayenne 69A	.347	8.8	14.0	64
Carolina 7	.525	10.8	13.5	45
Seedless cayenne	.368	12.5	12.9	43
Carolina 7 D[1]	.598	8.1	9.3	46
1-M-1 D[1]	.785	7.4	10.4	32
1-M-1	.726	9.2	14.2	18
Carolina 7 S[2]	.440	8.6	13.3	18
1-M-1 S[2]	.558	9.1	14.8	0

[1] Allowed to stay on the plant until dried and shriveled.
[2] Harvested when fully colored but succulent.

TABLE 2

Initial color, moisture, and crude fat content in relation to the extremes in color stability of 80 strains of cayenne pepper

Strains	Color retention after 4 months at 25° C.		Initial color		Moisture		Crude fat	
	Range	Average	Range	Average	Range	Average	Range	Average
	%	%	$K_2Cr_2O_7$ equivalents		%	%	%	%
The ten highest in color retention	60.5-75.5	65.3	.276-.503	.381	6.0-8.3	6.8	10.4-17.6	13.9
The ten lowest in color retention	13.2-25.0	19.8	.282-.490	.383	6.0-7.9	7.1	9.0-11.8	10.4

TABLE 3

Fractions of pepper pigment of 1950 peppers
Percent of total color of the hexane extract

Variety	Free xanthophyll	Ester xanthophyll	Carotene non-saponifiable	B-carotene mg./gram dry pepper
	%	%	%	
Louistana sports				
New	10.5	81.3	8.1	8.0
Aged (70.8%)[1]	4.9	61.3	10.8	2.9
Long cayenne 69A				
New	8.8	78.6	12.7	5.0
Aged (44.2%)[1]	6.6	67.8	10.4	1.2
"Seedless" cayenne				
New	3.9	87.8	8.3	9.2
Aged (35.9%)[1]	6.6	60.6	7.5	1.5
"Stock" cayenne				
New	7.4	85.4	7.2	4.2
Aged (65%)[1]	4.9	66.0	8.6	1.8
Paprika Carolina 7				
New	18.5	74.1	7.4	5.7
Aged (35.2%)[1]	11.1	64.7	7.1	0.97
Paprika 1-M-1				
New	12.1	77.2	10.7	13.0
Aged (30.8%)[1]	7.9	51.5	7.2	0.97

[1] Percent of total color left after 11½ months of aging at 25° C.

Effect of Various Storage Conditions on Color Retention

Light. Ground cayenne and paprika peppers were stored in glass bottles and in tins[c] at 25° C. for 10 months. Direct sunlight was not allowed to strike the samples. No significant difference in color retention between samples in the two containers was noted. All the samples in bottles showed surface bleaching after several months of storage. This was not indicative of color stability. With the more color-stable peppers, the inner surface stayed bright for many months. With the color-unstable samples, internal fading was soon apparent. The color of the samples in tins faded uniformly with time.

Air. Samples of the dried ground paprikas and cayennes were stored in Kraft paper bags to allow free access of air, at 37° C. and at 25° C. These were found to be definitely poorer in color retention over a 10-month period than the same peppers stored in stoppered glass bottles.

Temperature. Loss of color was markedly slower in all the samples when stored at 5° C. but showed the same general order of color stability as at 25° C. This phenomenon has long been known by the pepper industry and refrigerated storage is widely used. However, two disadvantages were found in depending on refrigeration for color preservation. A color-unstable pepper would retain its original color very well for some months at 5° C., but then the sample would start to lose color rapidly—losing practically all its red color within a few weeks at 5° C. The second disadvantage was the increased loss of color over that of the newly harvested pepper when a sample was removed from 5° C. storage to 25° C. or 37° C. Such a "warm" storage following refrigerated storage can be considered to simulate the passage of the pepper from the processor to the grocer's shelves to the homemaker. When first taken from the refrigerator, these samples had a color concentration of 90-100% of the original color of the newly harvested pepper. On storage at 37° C. or 25° C., the previously refrigerated samples lost color more rapidly than did the original newly harvested samples at 37° C. or 25° C. Apparently, changes in the pepper had been taking place at 5° C. which caused accelerated color destruction on subsequent storage at 25° C. or 37° C. These changes were not apparent in the pepper when taken from the refrigerator, either in color, taste, or smell. This behaviour was characteristic of the color-unstable peppers (Figure 2). Color-stable peppers did not show this acceleration of color loss after refrigeration for a few months, when subsequently stored at 37° C. With longer refrigeration, however, such acceleration was found. Spanish paprika, a very color-stable paprika, retained 98% of its original color after 12 months' storage. A sample taken from the refrigerator and stored at 37° C., lost color more rapidly than did this paprika when first obtained (Figure 2).

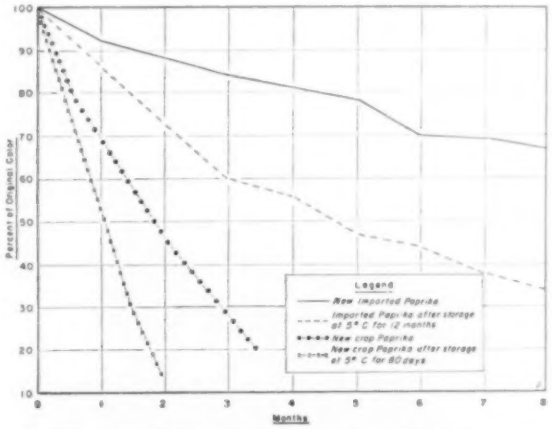
Percent of Original Color
Months
Legend
New Imported Paprika
Imported Paprika after storage at 5° C for 12 months
New crop Paprika
New crop Paprika after storage at 5° C for 80 days

Figure 2. Differences in rate of loss of color between paprikas at the time of harvesting, and after storage at 5° C.; when placed at 37° C.

Storage at 37° C. increased the rate of color destruction markedly over that at 25° C. for all kinds of peppers. Aging at this temperature came closer to following the course of ordinary aging than did any of the shorter methods tried. The large distinctions of color stability which occurred between very unstable and very stable paprikas or cayennes were apparent in 2 to 3 weeks. With 25° C. storage, this color distinction would take several months to appear. Small distinctions between peppers similar in color stability, which would show up by the relatively slow process of aging at 25° C., were often obscured by the speed of discoloration at 37° C.

Whole pod vs. ground pepper. Whole pod cayenne peppers, 69A, were placed in a mesh bag, an asphalt-laminated Kraft paper bag, and in large glass bottles. Carbon disulfide, ethylene dichloride, or carbon tetrachloride (commonly used insecticides) were added in

[c] Courtesy of The McCormick Company, Baltimore, Md.

5 ml. portions at bimonthly intervals to several of the samples in bottles. The samples were kept at 25° C. in the dark. Samples were also kept in glass jars and in Manila paper bags at 5° C., and at 37° C. Some of this pepper was ground and stored at 25° C., 37° C. and 5° C. in glass jars and in Manila paper bags. Color changes were followed at intervals over a 12-month period. Unless the difference in color loss between samples was 10% or over, it was not considered significant.

No significant difference in color retention between whole pod peppers and ground pepper was found at 5° C. nor at 25° C. storage. The ground pepper lost color somewhat more speedily than did the whole pod pepper at 37° C. (Table 4).

TABLE 4

Color retention of whole and ground cayenne pepper after 12 months' storage

Treatment	Percent color retained
Whole Pods	
5° C.	
Bottle	84
Bag	85
25° C.	
Mesh bag	67
Waterproof bag	61
Bottle	60
+ Carbon tetrachloride	59
+ Carbon disulfide	69
+ Ethylene dichloride	62
37° C.	
Bottle	19 (4 months 32)
Bag	21 (4 months 35)
Ground	
5° C.	
Bottle	89
25° C.	
Bottle	55
Bag	42
37° C.	
Bottle	0 (4 months 20)
Bag	0 (4 months 10)

In contrast to the ground pepper, the whole pod pepper retained color as well in air-pervious containers as in closed bottles. Temperature of storage rather than the kind of container, or whether the pepper was ground or whole pod, was the determining factor in color stability.

Rancidity in relation to color loss. No organoleptic signs of rancidity were evident in the cayenne peppers or Spanish paprika discolored by storage at 37° C. or at 25° C. With the color-unstable paprikas, such rancidity often accompanied loss of color.

Rancid lard was mixed with a color-stable cayenne pepper in equal amounts. Ninety percent color destruction was found after 12 months' storage at 25° C. Thus, rancid fat *per se* can cause pigment destruction in ground pepper.

Peppers which had been found to be color unstable were mixed with color-stable peppers in the proportions of 1 to 10 (a) before either was aged and (b) after the unstable pepper was discolored by aging to at least 10%. With cayenne peppers as the added component, no acceleration of color loss in the color stable peppers was found on aging at 25° C or 37° C. Addition of the aged solid pepper to hexane extracts of color-stable pepper did not cause increased loss of color over a 12-month period.

The effect of addition of the very color-unstable paprikas before discoloration as in (a) to color-stable peppers, depended upon the degree of color stability of the latter. Spanish paprika which was very color stable was not affected. Cayenne 69A, somewhat less stable in color, showed an early acceleration of color loss of about 10%. No further acceleration of color loss for a 12-month storage period was found.

Addition of discolored rancid paprikas to color-stable peppers, as in (b), caused an increase of 5-10% in color loss within the first month of storage. Thereafter no acceleration of color loss was noted. On addition of the discolored rancid paprikas to hexane extracts of color-stable peppers, losses of as much as 50% of the color were noted within 30 days, but thereafter color loss was very slow.

Addition of the stable Spanish paprika or of stable cayennes to color-unstable peppers, 1 part in 10 (as a means of stabilizing the color of the latter) was unsuccessful. Although the total color loss might be lessened with a very stable pepper in combination with a very unstable one, there was merely a delay of several weeks over the course of the color loss of the unstable pepper. This was probably due to the residual stable color of the added pepper. Addition of the concentrated hexane extract of a stable paprika or cayenne to an unstable solid pepper, providing more intimate contact, 1 part to 20, did not decrease color loss.

Seeds. When the seeds were removed from samples of long cayenne 69A before grinding, no consistent or large difference in color retention between it and the same non-seeded pepper was noted on aging at 5° C., 25° C. or 37° C. (Figure 1). Similarly the addition of 10 or 20% of ground cayenne seed to 69A did not increase color loss. The sterile type did not retain its color better than the regular long cayenne (Figure 1). Removal of the seeds gave a product with a better initial color than the unseeded pepper had. Percentage retention of the color did not differ, however. The suggestion that pepper from which seed is removed is better than unseeded pepper *(2, 10)* may be ascribed to the brighter appearing initial product rather than to an adverse effect of seeds.

Tests for indicating color stability of newly harvested pepper. As shown above, initial color, crude fat or moisture concentration, or pigment fractions of newly harvested peppers were not indicative of subsequent color stability of peppers.

The following procedures caused rapid and differential loss of color in pepper but did not parallel color loss at 25° C: 24 hours at 100° C. or 48 hours at 70° C. for the solid pepper; exposure of the hexane extracts of pepper to ultraviolet light; or addition of rancid fat or rancid discolored paprikas to hexane extracts. Exposure of the solid pepper to ultraviolet light resulted in non-differential surface bleaching of all samples within 24 hours.

Harvesting practices. The degree of maturity of the pepper fruit at harvesting was found to affect the

subsequent color stability of the dried, ground pepper. In the Piedmont section of South Carolina, not more than two harvests are usual. At each harvest, two degrees of maturity were taken. Pods were picked when fully colored but still succulent, designated as S_1 and S_2 for the first and second harvest, respectively. The fully colored pods were allowed to stay on the plant until they were dehydrated and somewhat shriveled, designated as D_1 and D_2 for each harvest. This is necessarily an arbitrary classification but corresponds to the extremes of harvesting practices.

It was found that three criteria of color were influenced by these differences in harvesting: (1) the initial concentration; (2) the percentage retained on aging; (3) the total amount retained on aging. As with the varieties or strains discussed above, a pepper with a high initial color concentration was not necessarily a desirable one after several months of storage. Percentage retention of this color could be so poor that another pepper with a lower initial color but better retention, would be preferable from a color standpoint. The most desirable pepper would be one with a high initial color concentration which was retained well, thus giving a good total color after storage, whether picked as S_1, S_2, D_1 or D_2.

A comparison of 28 pairs of cayenne strains for one year is given in Table 5. Part of the superior color after storage of the D samples of the first harvest may be ascribed to superior initial color, but the change of 9 samples from S = D in initial color for the first harvest, to D superior to S after aging, is due entirely to better percentage color retention.

TABLE 5

Color retention of cayenne strains harvested as succulent ripe, S, and after remaining on the plant until dried and shriveled, D

Color concentration	(1) D better than S by at least 10%	(2) S = D	(3) D poorer than S by at least 10%
	number of samples	*number of samples*	*number of samples*
First harvest			
Initial [1]	12	14	2
Within a 6 months storage period at 25° C.[3]	21	5	2
	(11)[2]	(3)[2]	(2)[2]
	(9)[3]	(1)[3]	
	(1)[4]	(1)[4]	
Second harvest			
Initial	7	0	0
Within a 6 months storage period at 25° C.	7	0	0

[1] The samples in each column included the same general range in initial color.
[2] Samples originally in column 1.
[3] Samples originally in column 2.
[4] Samples originally in column 3.
[5] There was a wide range of color stability between pairs of strains. In instances in which discoloration would be complete at 6 months, comparisons were made after 4 months of storage.

The initial color of South Carolina paprikas picked as the D degree of maturity was superior to that of samples picked at the S stage. Onset of rancidity obscured the effect of storage.

First harvest compared with the second. The greatest difference between first and second harvests was found at the S degree of maturity (Table 6). The poorest initial color and color retention after storage of any of the variations in harvesting were found at the S stage of the second harvest. The peppers for which a second harvest was available were those strains which had proved to be the more color stable of a large group

TABLE 6

Color retention of cayenne strains
First harvest in comparison with second harvest

Color concentration	S_1 better than S_2 by at least 10%	$S_1 = S_2$	S_1 poorer than S_2 by at least 10%
	Picked succulent ripe (S)		
	number of strains	*number of strains*	*number of strains*
Initial	4	2	0
After 4 months at 25° C.	5	1	0
	D_1 better than D_2 by at least 10%	$D_1 = D_2$	D_1 poor than D_2 by at least 10%
	Picked dried ripe (D)		
	number of strains	*number of strains*	*number of strains*
Initial	1	4	1
After 4 months at 25° C.	2	4	0
	(1)[1]	(3)[2]	
	(1)[2]	(1)[3]	

[1] Samples originally in column 1.
[2] Samples originally in column 2.
[3] Samples originally in column 3.

in other years when "field run" samples were tested. "Field run" of Louisiana Sports and P. I. 159-236 had proved to be color-stable peppers (Figure 1), but the S_2 samples were much inferior in initial color and color retention. Although the samples are few in number for the second harvest, the poor showing of S_2 in what would otherwise be considered a color-stable pepper indicates the necessity for a consideration of harvesting practices before a strain or variety is termed color stable.

In the field, S_2 would often be picked with D_1. These were ground together in the proportions of 1 to 10. No acceleration of color loss in the more stable D_1 by the added S_2 was found.

Of the 28 paired strains of cayenne, only one showed equal color retention at all stages of harvesting. This strain, however, had both a poor initial color and low percentage retention. Three strains met the criteria of good initial color and good retention of this color for both S and D of the first harvest. One of these was not acceptable for further breeding because of characteristics other than color. Of the other two strains, the second harvest succulent ripe stage (S_2) was very poor in initial color and stability for one; and both S_2 and D_2 were poor for the other.

DISCUSSION

Although the degree of maturity at harvest and the time at which the harvest was taken, as well as storage conditions, affected the color stability of the dry ground peppers, these factors did not account for the difference in color stability found between varieties and between strains of peppers. The lack of correlation between total initial color or color fractions and the ability to resist

discoloration suggests that the amount of pigment—or whether it is in the free or esterified form—is relatively unimportant. The ability to withstand color destruction exists independently of the initial color concentration.

The retardation of color loss by certain oil or fat-soluble antioxidants *(6, 11)* suggests that a lack of natural antioxidants contributes to color loss on storage of peppers. If a high natural antioxidant content were the sole factor in accounting for the better stability of some varieties or strains, it would be expected that addition of a rancid pepper to a color-stable one would eventually accelerate color loss. But such was not the case. Early small acceleration was noted, but there the process stopped. A small proportion of the pigment was affected by the addition of the rancid pepper; the major part was not affected. This suggests that other factors may be involved.

Since the largest proportion of the pigment is in the ester form, it may be that the carotenoid esters in the color-stable peppers are not so easily split into their component parts as the esters of the color-unstable peppers. Once the ester linkage is broken, the carotenoid portion is acted upon by light, air, and heat, all known to be destructive of carotenoids. The degradation products of the fatty acids split from the esters, and possibly other pro-oxidant substances in the peppers, could cause further destruction. A lack of natural antioxidants plus easily split esters would explain the very rapid discoloration noted in some samples. In the more color-stable peppers, the high antioxidant content plus more stable esters would lead to slow, more uniform discoloration.

SUMMARY

Color stability in cayenne and paprika peppers was not correlated with either initial color concentration, moisture or crude fat content, or proportions of free to esterified xanthophylls or carotene. Destruction of color by heating at 70° C. or by the action of rancid fat or ultraviolet light on hexane extracts of the peppers did not parallel color loss on ordinary aging. Storage at 37° C. caused accelerated color loss and paralleled that found on aging at 25° C.

The temperature of storage had more effect on the color stability of the pepper than did light, the kind of container, or whether the pepper was stored as whole pod or ground. Storage at 5° C. slowed the rate of discoloration but did not affect the inherent color stability of the variety or strain of pepper.

Addition of color-stable peppers to color-unstable ones, 1 part in 10, did not significantly increase their color stability on storage. Addition of color-unstable cayenne pepper to color-stable peppers did not increase subsequent color loss. Addition of cayenne peppers discolored by aging, to color-stable peppers did not increase subsequent color loss. Addition of very rancid aged paprika pepper caused slightly increased color loss in color-stable peppers, initially, but no evidence of a catalytic effect was found.

Cayenne pepper allowed to ripen and dry on the plant had a better initial color, and better color retention than pods picked when fully colored but succulent.

Removal of seeds or addition of 10 or 20% of seeds to cayenne pepper did not affect the color stability.

Acknowledgment

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Evaluation of Certain Methods to Determine Maturity in Relation to Yield and Quality of Yellow Sweet Corn Grown for Processing[a]

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THE STAGE OF MATURITY of sweet corn grown for processing has considerable influence on yield and quality. The yield of the crop increases as the stage of maturity advances because of the addition of starch and other solid matter in the kernels, but the quality of both immature and overmature kernels is inferior. Since the consumer is becoming increasingly aware of quality, a thorough knowledge of the relation between stage of maturity and quality of finished product is important. An accurate and preferably a rapid method of estimating the maturity of raw sweet corn so that prime quality and satisfactory yield can be obtained is equally desirable. The experiments presented herein should offer useful criteria in this regard.

As early as 1923, Appleman *(3)* established that after sweet corn reaches the prime canning condition, it deteriorates rapidly. His results indicated that the processor could predict the approximate date and the length of time when a crop of sweet corn would be in the best canning stage. His predictions were based on the rate of ripening and the chemical make-up of sweet corn which, he reported, are controlled by temperature. Lana and Haber *(17)* and Seaton *(19)* studied the import of planting and harvesting dates of sweet corn. From their observations they developed a "heat summation" or "heat unit" system, based on the mean temperatures for the growing period of the crop. The summation of the "degree days" or "degree hours" above the base temperature at which the growth takes place correlates closely with plant development. The method is applied by some canners in scheduling successive plantings, in predicting the incidence of insect and disease infestations, and in forecasting harvest dates.

Currently, many physical and chemical methods are employed in selecting raw corn suitable for processing. Bailey and Bailey *(5)* found that the pericarp becomes thinner and harder as corn matures. Caldwell *(6)* suggested the puncture test to determine toughness of the pericarp. Haber *(12)* showed varietal variations in pericarp content. Pratt *(18)*, Scott *(20)*, Geise, Homeyer, and Tischer *(10)* and Williams, McComb, and Washauer *(23)* reported that various moisture tests and the succulometer *(15)* test can be considered as measures of succulence. Johnson and Bennett *(13)* offered the turbidity test for determining the maturity of sweet corn. Scott, Belkengren, and Ritchell *(21)* presented a quick method to determine maturity of raw sweet corn by use of the refractive index. The refractive index may be considered a test of flavor also, since it measures soluble solids content—which contains sugars, primarily. However, Culpepper and Magoon *(8)* concluded that high sugar content does not always mean high flavor. They suggested that the ratio of water solubles to total polysaccharides may be an index of quality. Gould, Krantz, Jr., and Mavis *(11)* observed that the most reliable method for determining the maturity of fresh, canned, and frozen yellow sweet corn was to establish the alcohol insoluble solids content.

The maturity and quality of sweet corn seem to be the sum of the physiological, physical, and chemical make-up of the kernels.

EXPERIMENTAL

Sweet corn used in these tests was grown at the Farmington Field Station of the Utah Agricultural Experiment Station under soil conditions of high fertility and moisture. The study was made on 5 commercial varieties from two seasons: Golden Cross Bantam, F-M Cross, and Iochief, grown in 1952; and Golden Cross Bantam, Calumet, and Victory Golden, grown in 1953.

In order to simulate commercial conditions as closely as possible, 3 varieties in 3 replications were planted on each of 3 dates so as to give a normal spread during the season. For each of these 3 plantings of 3 varieties, harvests were made at 5 intervals, selected to give a range from immature to overmature corn.

The percent moisture content in the kernels of corn was used as a basis for determining the maturity stages. The maturity levels were selected to correspond with the following moisture levels: 80%, 75%, 70%, 65%, and 60%.

Time of harvest was determined by the Steinlite electronic moisture tester. Moisture values in general were within plus or minus 2% of the above values. A series of pre-harvest tests indicated that in some varieties, the corn at 80% moisture was too immature to process. Therefore, the first harvests of the varieties were made with as high a reading as was considered practical, judging by other visible signs of maturity.

Maturity and yield records were taken for each harvest lot. The cut kernels were mixed well and the moisture content was determined by the Steinlite moisture test *(1)* and calcium carbide method *(23)*. The soluble solids were determined by refractive index of the expressed juice *(21)*, and succulometer *(15)* values were recorded. The turbidity test was made on raw samples of sweet corn according to the instructions of Johnson and Bennett *(13)*. Samples in the form of slurries in 95% ethyl alcohol were prepared for the determinations of percent pericarp, moisture by the vacuum oven method, alcohol insoluble solids, and reducing and total sugar.

For each of the harvest lots, samples consisting of 12 to 16 ounces of blanched, cut, and washed kernels were prepared in sufficient quantity for processing by both canning and freezing. Canning and freezing were carried out according to accepted commercial practices. In order to provide for control lots, enough samples of Golden Cross Bantam of prime maturity

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(74 to 76% moisture) were prepared to be used as a standard in quality appraisal tests.

In order to characterize the processed samples as completely as possible by the same methods as were used on the raw materials, the following determinations were made in duplicate on the canned and frozen samples:

a. Percent moisture by the vacuum oven method.
b. Percent soluble solids by refractive index of expressed juice.
c. Succulometer values.
d. Percent pericarp.
e. Percent alcohol insoluble solids.
f. Percent reducing and total sugars.

Maturity records taken during the study included days to maturity and holding ability of the varieties.

Since cumulative degree days *(19)* as a method of estimating harvest dates has received much popular interest in the past few years, temperature records were kept and cumulative degree days were calculated. The number of degree days necessary for maturing a variety was obtained by accumulating the degree days above the base temperature 50° F.

In the vacuum oven method of determining the percent moisture, the aliquot was weighed, brought to apparent dryness, air dried for 12 hours at 70° C. and then placed in the vacuum oven for 48 hours at 70° C. The percent moisture was also determined by the calcium carbide method *(23)*. The percent alcohol insoluble solids and the reducing and total sugars were determined *(4)*.

The succulometer values were recorded on the canned and frozen samples. The canned samples were drained on a slanting 8-mesh screen for 2 minutes prior to weighing out 100 g. samples. Pressure of 500 pounds was applied for 3 minutes. The juice was collected and used as a measure for the degree of succulence. The raw and frozen samples were soaked in water for 5 minutes, drained for 2 minutes on a sloping 8-mesh screen, and weighed. The juice was then expressed and measured.

The refractive index *(21)* of the expressed juice of raw, canned, and frozen sweet corn was made with the aid of an "Abbe" type refractometer. Because of the opaqueness of the juice, its index was difficult to read under a sodium light. A regular microscope illuminator proved to be a satisfactory source of light. A water bath maintaining a constant temperature of 20° C. was used in connection with the refractometer.

The color measurements were made with Hunter Color and Color Difference Meter *(1)* using the "L" position lens. The raw and blanched ears were held rigidly in place over the large orifice plate of the instrument by a specially designed mounting. Color measurements on blanched ears were made in the same positions as readings on raw kernels in order to measure the changes in color as the result of the blanching. The readings were made on 4 ears from each of the samples and at 2 places on each ear. The canned samples were drained and prepared for the color readings in a petri dish. The frozen samples were prepared similarly after cooking. The percent pericarp determinations were made according to the method of Kramer *et al. (16)*. The method was modified by using duplicate 100 g. samples blended with 200 ml. water for 5 minutes and dried for 2 hours at 100° C.

The subjective appraisal tests were conducted on the canned and frozen samples. The canned samples were brought to a boil before being judged. The frozen corn was placed in salted boiling water (one teaspoon of table salt per quart of water) and cooked for 6 minutes after the water resumed boiling. The tests were made by a panel of 8 judges according to plan 13.7 of Cochran and Cox *(7)*. Flavor, skin texture, endosperm texture, and color were each rated separately on a 1 to 10 basis (1, *unacceptable;* 10, *most desired*). The control standard of Golden Cross Bantam (74-76% moisture) for the appraisal tests was given a rating of 8.

RESULTS AND DISCUSSION

Degree days. Each variety required a different number of degree days for maturity and varied for the different plantings each season (Table 1), suggesting

TABLE 1

The number of degree days required for growing three varieties of sweet corn to five predetermined moisture percentages[1] in 1952 and 1953

Moisture percentage	Varieties (1952)			Varieties (1953)		
	Iochief	F-M Cross	Golden Cross Bantam	Calumet	Victory Golden	Golden Cross Bantam
	degree days	*degree days*	*degree days*	*degree days*	*degree days*	*degree days*
78	1767	1710	1735	1811	1888	1762
75	1842	1766	1811	1891	1944	1839
71	1954	1828	1872	1971	2015	1910
66	2065	2042	2012	2099	2121	2059
62	2168	2131	2108	2207	2220	2175

[1] Used as a measure of maturity stage.

that the number of degree days has a great variability for practical estimates of harvest—at least in the growing area of Salt Lake City and vicinity. This finding is in agreement with the findings of Lana and Haber *(17)*. However, Lana and Haber *(17)* and Seaton *(19)* reported that the heat unit method can be used as an aid in scheduling spaced plantings for a better spread of harvest.

Days to maturity. Days to maturity has some value for the grower in estimating the probable time of harvest of a specific variety. The days to maturity of different varieties are shown in Table 2.

TABLE 2

The number of days required for growing three varieties of sweet corn to five predetermined moisture percentages in 1952 and 1953

Moisture percentage	Varieties (1952)			Varieties (1953)		
	Iochief	F-M Cross	Golden Cross Bantam	Calumet	Victory Golden	Golden Cross Bantam
	days	*days*	*days*	*days*	*days*	*days*
78	82	80	81	84	87	82
75	86	82	84	87	89	85
71	90	84	87	90	93	88
66	96	94	93	97	98	95
62	102	100	98	102	103	101

Holding ability. The period during which the sweet corn remained at usable quality varied with varieties studied. For example, the quality of F-M Cross was retained for a period of 12 days or 275 degree days; this variety was followed in order by Golden Cross Bantam, Iochief, Calumet, and Victory Golden.

Yield. The main consideration for a grower of sweet corn is the yield or income per acre. The processor, on the other hand, is concerned with recovery of kernels which is the percentage of kernel weight as compared to the total weight of corn with husks on. In view of these facts, the two year average of yield data are summarized on the basis of percentage of moisture at each harvest interval, as yield per acre and recovery percentage. The yield and recovery percentages increased rapidly as the corn matured. The yield data reveal that the recovery percentage might be considered as a varietal characteristic (Table 3).

Maturity measurements. The five different tests of maturity used in the study follow the same pattern and are considered satisfactory tests. The summarized data are presented in Figure 1. A theoretical line is drawn in the figure to represent 100% correlation. The methods

TABLE 3

Total yield per acre and recovery percentage[1] of three varieties of sweet corn grown at five predetermined moisture percentages in 1952 and 1953

Moisture percentage	Varieties (1952)						Varieties (1953)					
	Iochief		F-M Cross		Golden Cross Bantam		Calumet		Victory Golden		Golden Cross Bantam	
	Yield per acre	Recovery	Yield per acre	Recovery	Yield per acre	Recovery	Yield per acre	Recovery	Yield per acre	Recovery	Yield per acre	Recovery
	tons	*%*	*tons*	*%*	*tons*	*%*	*tons*	*%*	*tons*	*%*	*tons*	*%*
79	6.3	32	7.0	31	6.4	26	5.5	25	6.7	35	5.8	19
75	6.1	37	7.1	38	6.7	28	6.4	36	6.5	35	6.6	26
70	7.3	47	7.6	43	7.1	30	6.8	38	7.4	41	6.1	33
68	8.1	49	7.9	48	7.2	46	7.1	43	7.6	46	6.4	42
63	7.6	53	7.7	50	8.0	50	6.7	51	6.2	49	7.3	42

L.S.D. 0.05 between varieties:
For yield in 1952, 0.6; and in 1953, 0.6.
For recovery in 1952, 2; and in 1953, 3.
L.S.D. 0.05 between maturities:
For yield in 1952, 0.6; and in 1953, 0.7.
For recovery in 1952, 3; and in 1953, 4.

[1] Percentage of kernel weight as compared to total weight of corn with husks on.

presented in Figure 1 correlate satisfactorily over the entire range. However the time involved to perform the various tests varied greatly. The vacuum oven method required 62 hours. The calcium carbide test required 30 minutes. The time for the succulometer test was 12 minutes and the Steinlite readings were obtained in 9 minutes. The refractive index test was the shortest and it could be completed in 2 minutes. It should therefore be given preference over other methods where the time is an important factor.

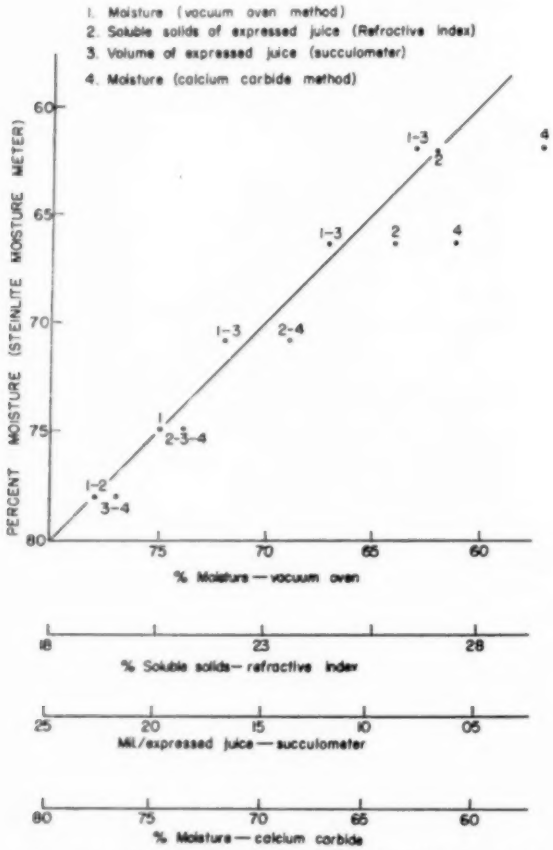

Figure 1. Comparison of four methods of testing sweet corn maturity to the Steinlite moisture method and a theoretical line of agreement.

Turbidity test. The turbidity test of maturity for three varieties, Golden Cross Bantam, Calumet, and Victory Golden, exhibited the same general trend (Figure 2). The readings of the spectrophotometer decreased until about 70% moisture but then increased to form a V-shaped line. In the test, a time factor must be considered, and the amount of distilled water required could become prohibitive under certain field conditions. The possibility of adopting this test should be considered in some phase of studying performance of varieties.

Color measurements. Eastmond *et al. (9)* reported the differences in the reflectance of spectrophotometer properties of sweet corn with maturity. To study this aspect further, measurements were made on samples from all plots using the Hunter Color and Color Difference Meter *(2)*. During the 1952 season readings on the Hunter color meter (Rd, a, and b) were made, and total color differences calculated. Study of the data and their analyses indicated that the "a" scale (yellow-red) readings showed the greatest change with sweet corn maturity. During the 1953 season only the "a" scale readings were made. The "a" scale reading indicates intensity of yellow kernels of sweet corn. The low number indicates light yellow whereas high number indicates deep yellow to orange. A general trend for color change from yellow to orange occurred as the corn matured. However, there was considerable fluctuation in the color readings as determined on different regions of each ear, being particularly true of the raw and blanched samples. The values of "a" obtained for each area examined on a given ear were reproducible. The values obtained on different regions of the same ear often varied over a wider range than the average of those between adjacent maturity levels. Thus, although there is a general change of color as sweet corn matures, it would be difficult to establish ranges of color which would be usable as a means of separating samples accurately into various maturity levels. Subsequent to blanching the corn, the yellow color was brightened. Further change occurred after canning as well as after cooking the frozen samples. The canned corn seemed to darken with the canning process and this was especially true of the im-

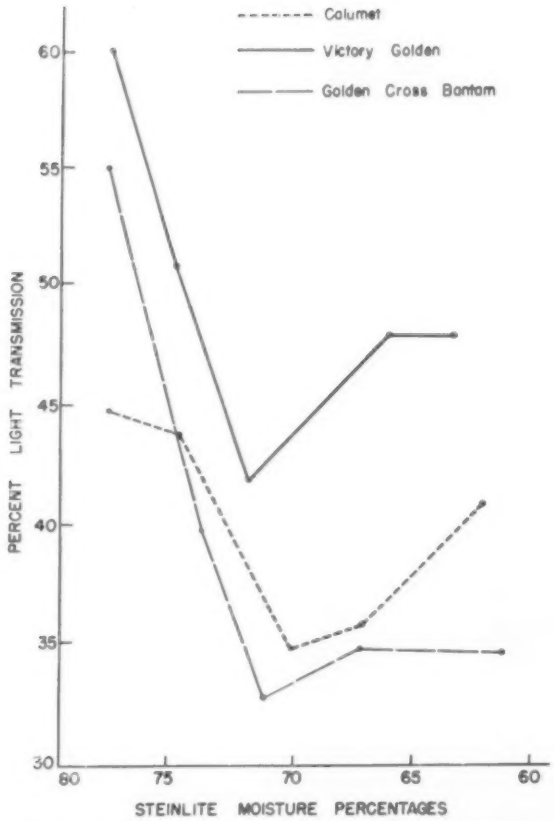

Figure 2. Percent light transmission through an aqueous suspension from three varieties of sweet corn grown in 1953 as compared to moisture percentages obtained by Steinlite moisture meter.

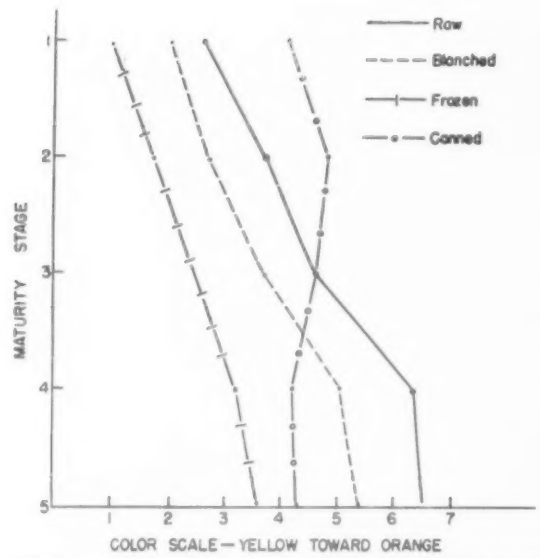

Figure 3. Average color changes obtained by Hunter Color and Color Difference Meter in raw, blanched, canned, and frozen samples of three varieties grown at five predetermined maturities in 1952 and 1953.

mature corn. The average color changes are shown in Figure 3. A few exploratory measurements were taken on certain samples after grinding the kernels of corn. Variations of color due to maturity were rated, and there was greater uniformity of samples within a given maturity than was the case with the unground samples.

Pericarp. The amount of pericarp increased as the corn matured. The increase was from 1.6 to 3.4% on raw corn. Following blanching and freezing, the percentages ranged from 2.0 to 3.9. When the corn was canned, the percentages were 1.2 to 2.4 (Table 4). The varietal dierences were noticeable, especially in the size of the flakes after grinding and drying which gave an impression that toughness of pericarp was a varietal characteristic. The dried pericarp samples showed the difference in the size of flakes for the various varieties at the 5 stages of maturity. The pericarp flakes of Iochief and Calumet were large at immature stages. Golden Cross Bantam had smaller flakes of pericarp and was followed closely by F-M Cross and Victory Golden.

Alcohol insoluble solids. Alcohol insoluble solids content could be used as a measure of maturity of sweet corn (Table 5); however, it is not a quick test. It was the most consistent test for the processed product since there was little difference between the results on the raw and the processed samples. A range of 18 to 22% alcohol insoluble solids was found to cover the best maturities for acceptable quality in sweet corn. The overall spread of these solids ranges from 13 to 36% and changes about 2¼% for every 5% change in moisture—which agree with the observations of Kramer and Smith *(15)*.

Reducing and total sugars. There was a rapid decrease of reducing sugars in sweet corn as it matured from 80 to 70% moisture; however, there was little change from 70 to 60%. The average reducing sugar

TABLE 4

The percent pericarp obtained from the raw, canned, and frozen samples of three varieties of sweet corn grown to five predetermined moisture percentages in 1952 and 1953

Sample	Moisture percentage	Varieties (1952)			Varieties (1953)		
		Iochief	F-M Cross	Golden Cross Bantam	Victory Calumet	Golden	Golden Cross Bantam
		%	%	%	%	%	%
Raw	78	1.5	1.4	1.2	2.0	1.5	2.0
	75	1.6	1.6	1.4	2.0	1.7	1.9
	71	2.0	1.7	1.4	2.4	1.8	2.0
	66	2.5	2.9	2.2	3.6	2.3	2.8
	62	3.2	3.7	2.9	3.8	3.3	3.7
Canned	78	1.3	1.3	0.9	1.3	1.2	1.1
	75	1.4	1.3	1.0	1.5	1.3	1.3
	71	1.9	1.5	1.3	2.1	1.6	1.5
	66	2.3	2.3	1.8	2.4	1.8	1.9
	62	2.9	2.7	2.0	2.6	2.1	2.2
Frozen	78	2.2	2.5	2.3	1.6	1.7	1.5
	75	2.8	2.7	2.6	2.0	1.8	1.6
	71	3.2	3.0	3.0	2.4	2.1	2.1
	66	3.6	4.0	3.7	3.2	2.5	2.9
	62	4.0	4.2	4.2	4.2	3.0	3.7

L.S.D. 0.05 for raw: *varieties*, 1952, 1.0; 1953, 1.7; *maturities*, 1952, 1.3; 1953, 2.2.
L.S.D. 0.05 for canned: *varieties*, 1952, 0.9; 1953, 1.8; *maturities*, 1952, 1.3; 1953, 2.2.
L.S.D. 0.05 for frozen: *varieties*, 1952, 0.7; 1953, 1.4; *maturities*, 1952, 0.9; 1953, 1.8.

TABLE 5

The percent alcohol insoluble solids obtained from the raw, canned, and frozen samples of three varieties of sweet corn grown to five predetermined moisture percentages in 1952 and 1953

Sample	Moisture percentage	Varieties (1952)			Varieties (1953)		
		Iochief	F-M Cross	Golden Cross Bantam	Calumet	Victory Golden	Golden Cross Bantam
	%	%	%	%	%	%	%
Raw	78	15.4	18.4	15.1	17.3	16.3	15.8
	75	20.5	19.5	18.5	21.4	18.6	21.0
	71	25.4	23.5	22.2	26.6	23.5	25.1
	66	29.7	32.6	29.7	31.2	27.4	30.7
	62	33.6	35.4	35.1	35.2	30.2	35.9
Canned	78	14.4	16.6	14.9	15.4	13.5	41.8
	75	17.4	18.2	17.5	18.3	14.7	17.0
	71	21.4	20.1	19.6	20.5	17.3	19.2
	66	25.4	25.7	23.6	24.4	20.2	23.3
	62	28.1	28.0	27.4	27.1	22.9	25.9
Frozen	78	15.8	18.4	16.4	17.3	13.2	16.1
	75	19.8	20.5	19.5	20.5	16.9	19.1
	71	24.8	22.9	22.1	23.7	20.3	22.5
	66	29.4	30.2	28.3	29.0	24.4	27.9
	62	33.6	34.0	32.7	32.6	27.6	32.1

L.S.D. 0.05 for raw: *varieties*, 1952, 2.4; 1953, 0.5; *maturities*, 1952, 2.8; 1953, 1.3.
L.S.D. 0.05 for canned: *varieties*, 1952, 2.1; 1953, 1.6; *maturities*, 1952, 2.8; 1953, 2.0.
L.S.D. 0.05 for frozen: *varieties*, 1952, 1.8; 1953, 0.8; *maturities*, 1952, 2.2; 1953, 1.1.

curves for raw, canned, and frozen sweet corn are presented in Figure 4. Blanching and canning not only lowered the percentage of reducing sugars but also made the amount more constant. The amount of total sugars was lowered by processing. The data for total sugars in the raw corn form a downward line (Figure 5).

Tri-metric test. This is a combination test, consisting of the Steinlite moisture test or succulometer values, percent pericarp, and the kernel size as proposed by Kramer *(14)*. Kramer states that this is a method by which any varietal or climatic variation could be overcome and the raw corn be rated at U. S. standards. Since all of the information required for the test was in the data except the measurements of 20 kernels, the measurement was taken and the test was applied in 1953. Under the growing conditions in the Salt Lake City area for the season the corn was rated lower by the trimetric method than by the U. S. standard ratings. Recently, Twigg *et al. (22)* proposed that another type of trimetric test consisting of percentage of alcohol insoluble solids, percentage of pericarp, and kernel size may have reliability to evaluate maturity of the processed corn.

Quality appraisal. The four quality factors of sweet corn usually considered by a consumer are flavor, skin texture, endosperm texture, and color. Each of these was judged separately in order that a more efficient evaluation of quality of the canned and frozen product (Table 6) could be made. The ratings show similar trends.

The skin texture increased in toughness as the corn matured. There were significant varietal differences in skin texture and in pericarp. The endosperm was watery and soft in the immature sweet corn. The highest rating for endosperm texture was at the 75% moisture level after which it increased in starchiness and received a lower rating. The color rating showed more variation than did the other quality factors. In the canned product some of the samples of the first two maturities of all varieties developed a grayish yellow or a caramelized

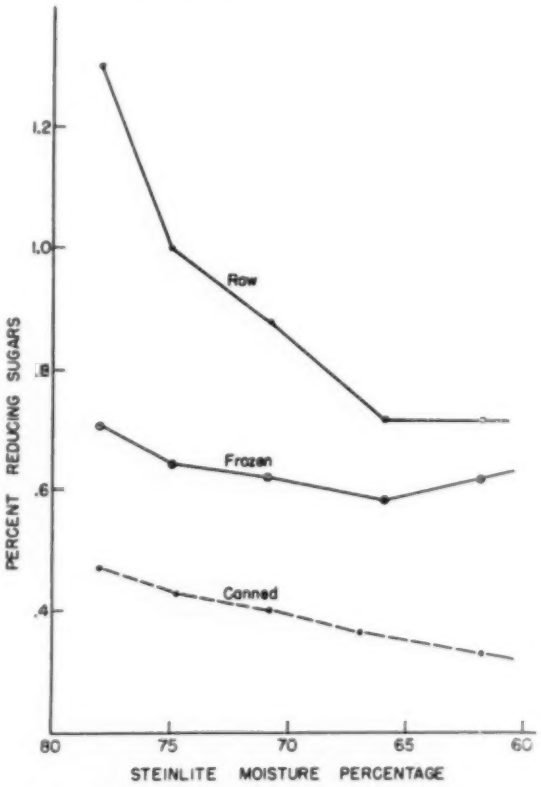

Figure 4. Percent reducing sugars of raw, canned, and frozen samples of three varieties of sweet corn grown at five moisture percentages as determined by Steinlite moisture meter in 1952 and 1953.

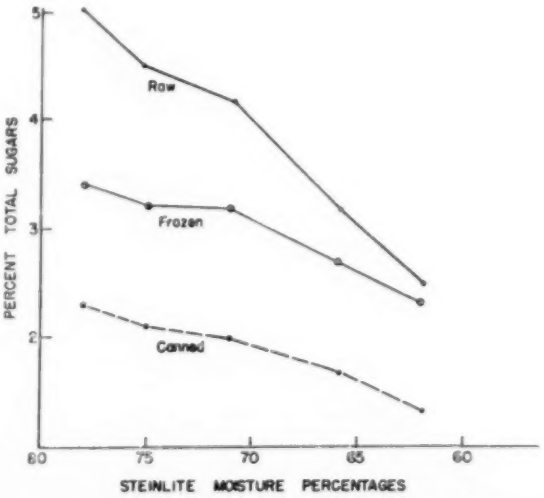

Figure 5. Percent total sugars of raw, canned, and frozen samples of three varieties of sweet corn grown at five moisture percentages as determined by Steinlite moisture meter in 1952 and 1953.

TABLE 6

The average appraisal ratings[1] given for canned and frozen samples from three varieties of sweet corn grown to five predetermined moisture percentages in 1952 and 1953

Variety/Year	Moisture percentage	Flavor		Skin texture		Endosperm texture		Color	
		Canned	Frozen	Canned	Frozen	Canned	Frozen	Canned	Frozen
		Rating	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*
Iochief (1952)	79	6.7	7.4	7.9	7.5	6.6	6.6	5.3	7.2
	75	7.0	7.2	7.2	6.0	7.1	7.2	6.5	7.6
	70	6.1	5.8	5.2	5.4	5.4	5.6	6.8	5.6
	68	4.0	2.7	3.0	3.3	3.0	3.1	6.4	4.7
	63	2.9	1.2	2.0	1.9	1.9	1.4	6.1	3.9
F-M Cross (1952)	77	7.1	7.9	8.1	8.1	6.8	7.3	4.5	6.6
	75	6.9	7.0	7.4	7.4	6.8	7.3	5.6	7.2
	72	6.6	6.5	6.7	6.3	6.5	6.6	6.2	7.4
	65	4.2	2.3	3.7	3.0	3.4	2.8	6.9	5.5
	62	3.0	1.2	2.5	1.9	2.2	1.3	6.5	4.9
Golden Cross Bantam (1952)	77	7.8	7.3	8.6	8.6	6.9	6.7	5.3	5.4
	75	7.9	7.7	8.5	8.3	7.6	7.8	6.7	7.2
	71	7.7	7.2	7.1	6.4	7.2	6.1	7.7	6.9
	65	5.0	3.5	4.4	4.0	4.1	3.5	6.3	4.6
	61	3.6	2.1	3.1	3.5	2.8	2.9	5.4	3.9
L.S.D. 0.05 for varieties		2.4	2.9	2.4	3.2	2.3	3.9	2.8	3.0
L.S.D. 0.05 for maturities		3.0	3.8	3.0	4.1	2.9	5.0	3.6	3.9
Calumet (1953)	78	5.8	6.0	6.2	8.0	6.2	6.6	3.9	4.3
	75	6.0	6.4	6.9	7.4	6.6	7.0	4.7	6.7
	70	5.9	5.9	6.0	5.8	6.1	6.3	6.0	7.0
	67	4.2	3.2	3.4	3.2	3.3	3.2	6.8	7.1
	62	2.5	2.4	2.1	2.2	2.1	2.1	6.5	6.3
Victory Golden (1953)	78	6.5	6.5	8.1	8.0	6.9	6.5	4.8	4.8
	75	6.7	6.8	7.8	8.1	7.0	7.0	5.1	6.3
	72	6.8	6.5	6.9	6.7	7.0	7.3	5.6	6.7
	66	5.1	5.3	5.4	5.2	5.4	5.1	5.9	5.7
	63	4.0	3.6	3.9	3.6	4.2	4.0	5.7	5.6
Golden Cross Bantam (1953)	78	6.8	6.7	8.4	8.2	7.3	6.9	5.8	6.3
	74	7.7	7.7	8.2	7.9	7.6	7.6	7.1	7.3
	71	6.9	6.9	6.7	7.0	6.6	6.9	6.8	7.6
	67	4.4	3.8	4.3	3.8	4.2	3.9	6.3	5.9
	61	3.1	2.6	3.2	2.6	2.9	2.2	5.4	5.0
L.S.D. 0.05 for varieties		0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
L.S.D. 0.05 for maturities		0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5

[1] 1 = poor; 10 = excellent; 8 = standard.

color. In general, however, the color increased in intensity with increasing maturity which resulted in low ratings for the overmature corn. An exception was Calumet which has a light colored kernel.

It is well recognized that quality, yield, and recovery are three basic points considered by consumer, grower, and processor, respectively. At a flat rate per ton of sweet corn, the grower of older corn would receive a higher income per acre. The processor would gain from 5 to 10% recovery but would obtain a lower quality product. It should be possible to take the quality curve, made by a study of the quality appraisal factors, and interpose it upon the yield and recovery percentage averages to arrive at a basis by which a study of differential could be made (Figure 6). Growers and processors should consider this possibility carefully and come to some definite agreement whereby the consumer can be guaranteed a top-quality product.

SUMMARY AND CONCLUSION

Experiments were conducted at the Farmington Field Station, Utah, in 1952 and 1953 to evaluate various methods to determine maturity in relationship to yield and quality of yellow sweet corn used for processing.

Five commercial varieties—Golden Cross Bantam, F-M Cross, and Iochief in 1952 and Golden Cross Bantam, Calumet, and Victory Golden in 1953—were planted. Growth and yield records were taken on each variety. The harvests were conducted at five intervals, spaced according to moisture percentage, to give a range from immature to overmature corn. The harvested corn was then sampled as raw, canned, and frozen product. Various physical and chemical tests were applied to determine the maturity which will yield satisfactorily and at the same time give high quality to the processed product. The quality was appraised by a panel of eight judges. An effort was also made to determine the most rapid and accurate method on which to select the best harvest time. The results and observations follow.

Growth measurement by accumulative degree days was not uniform enough to be of practical value but could be used as an aid in scheduling spaced plantings. Days to maturity of a given variety can be used as a harvest guide for the grower.

Yields increased as the corn matured because of the increased kernel weight. The varieties behaved differently in their total yield and holding abilities.

The five tests—Steinlite moisture meter; succulometer; percentage of moisture by vacuum oven method; calcium carbide method; and the percent soluble solids by refractometer—were adequate tests of maturity. The refractive index of expressed juice required the least amount of time.

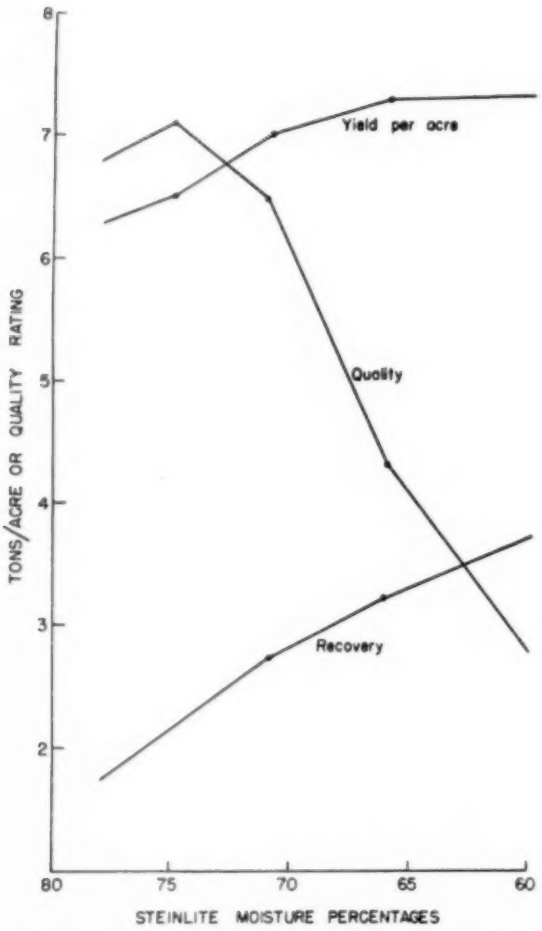

Figure 6. Average yield per acre and quality appraisal ratings for canned and frozen samples of sweet corn grown at five moisture percentages as determined by Steinlite moisture meter in 1952 and 1953.

The turbidity test was considered impractical because of the amount of distilled water required and the time involved to carry it out when compared to other tests.

Color by Hunter Color and Color Difference meter as a test of maturity was not recommended because of the variability of color on a single ear. Kernels on one ear could show as much variation as differences in maturity levels.

The percent alcohol insoluble solids showed the least change in values between the raw and processed samples and seems a satisfactory index of maturity.

The percent reducing and total sugars indicated a definite downward trend as the sweet corn matured, and there was a considerable loss in the processed product. Apparently, the sugar content was reduced most by length of processing time.

The quality appraisal of sweet corn consisted of four factors: flavor, skin texture, endosperm texture, and color. Each of these factors was definitely lowered as the corn matured to less than 76% moisture. This lowering of quality was most rapid as the moisture fell below 70%.

Acknowledgment

The authors wish to express the sincere appreciation to Professor B. H. Crandall and Dr. R. L. Hurst for advice and aid in experimental design and analyses of data; Dr. H. S. Olcott and other members of the Western Utilization Research Branch, Albany, California, for their advice and counsel on procedure and policy; and the members of the Horticulture and Home Economics Departments who served as judges on the taste panel.

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Effect of Aureomycin[a] Chlortetracycline On Fish Freshness[b]

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FRESH FISH, like many other protein-rich foods, are highly susceptible to spoilage. Principal among the various kinds of spoilage occurring in these foods is that due to bacterial action. Much effort has been expended in recent years in attempts to retard this type of deterioration in fish. Some control has been achieved through the use of refrigeration and ice, but it has become increasingly apparent with the vast expansion of the consumer market that improved methods of storage are needed. The development of the broad spectrum antibiotics, with their activity against a wide variety of bacteria, has opened up new possibilities in the control of the bacterial spoilage of foods.

For a number of years Tarr and his associates *(1, 2, 9, 10, 11, 12, 13)* have been investigating additives for increasing the storage life of cod and salmon. They introduced sodium nitrite for this purpose in 1939 and continued to study many other substances in attempts to find a more effective agent. In 1950 they were able to show *(12)* that small amounts of chlortetracycline extended the freshness of fish. Two years later in a subsequent publication *(13)* they found chlortetracycline to be more effective in preserving flesh foods (fish and meats) than any of the fourteen other antibiotics studied. They reported retardation of the bacterial spoilage of whole eviscerated fish by chilling with ice containing 1 to 4 p.p.m. chlortetracycline, by holding 6 days at —1° C. in sea water containing 3 p.p.m. chlortetracycline and by briefly immersing in a 50 to 100 p.p.m. chlortetracycline solution before icing. The results of their experiments published in 1954 *(11)* indicate that chlortetracycline is fairly stable in flesh at low temperatures but is readily inactivated by heating. Farber has also studied the comparative effectiveness of this antibiotic on fish storage and has recently reported *(4)* that a chlortetracycline dip at a concentration of 2 p.p.m. was most effective in prolonging the keeping quality of fish fillets. Foods other than fish which have been treated with chlortetracycline include beef *(3, 5, 8, 15, 16)* and poultry *(7, 17)*. The purpose of this paper is to present data which show the effectiveness of the antibiotic chlortetracycline in extending the freshness of several species of fish caught under commercial conditions.

MATERIALS AND METHODS

Three methods have been used in our studies on the effectiveness of chlortetracycline in prolonging the freshness of fish: organoleptic rating, microbiological assay for the antibiotic, and microbial count.

Organoleptic observations were rated according to the following system which will be used throughout the tables: A—putrid; B—strong odor; C—medium odor; D—slight odor.

The chlortetracycline determinations *(6)* were carried out on 5-g. samples (either dissected from whole fish or ground from steaks or fillets) homogenized with 20 ml. of pH 4.2 acid acetone in a Waring blender and allowed to settle in the refrigerator. Frozen fish were thawed overnight in the refrigerator at 3-5° C. before sampling.

The assays were done using *B. cereus* No. 5 (ATCC No. 10702) test plates containing 5 ml. of inoculated brain heart infusion agar (pH 5.5) per flat bottomed Petri dish (Pyrex No. 3162). Standard curves were prepared using untreated (control) tissue extracts as a diluent. Paper discs (S and S No. 740-E, ¼ in.) were dipped in the test solutions and were applied directly on the agar plates. Each sample was tested on 9 discs, using 3 discs per plate; standard chlortetracycline at a concentration of 0.1 γ/ml. was placed on each assay plate, one disc per plate.

All plates were incubated overnight at 26-27° C. and the inhibitory zones were measured using a Quebec colony counter equipped with an etched mm. scale. The standard curves ranged from 2 γ/ml. to 0.005 γ/ml. chlortetracycline; corresponding tissue values ranged from 10 γ/g. to 0.025 γ/g. The average zone sizes for the respective standard curve were plotted on semi-log paper (log dose versus mm. zone size). Zones obtained with the samples under test were averaged and adjusted to fit the standard curve as determined by the 0.10 γ/ml. standard, and the value in γ/g. tissue was calculated.

For microbial counts on fish, one-inch center steaks were removed from the area between the anal opening and the tail. The steaks were weighed and homogenized in a Waring blender in a volume of sterile water equal to 3 times the weight of the sample. Dilutions were prepared by adding 1 ml. to 99 ml. sterile water with subsequent serial dilutions carried out to 1×10^6. These dilutions were then plated out in Difco nutrient agar and incubated at 26° C. for two days. The colonies were counted on a standard colony counting device eliminating plates with less than 30 and more than 300 colonies. All dilutions and plates were prepared in duplicate.

The method of applying chlortetracycline to fish has depended on the mode of handling of the particular species. An ice was used for those fish which are usually iced round or gutted, an aqueous dip was used for those fish usually rinsed or pre-chilled, and a freezing brine was utilized for fish frozen by the immersion process. All fish were eviscerated.

EXPERIMENTAL AND RESULTS

Antibiotic activity has been found in fish treated with chlortetracycline and the uptake of this antibiotic has been detected whether processed by sea or fresh water immersion, by freezing brine, or by ice containing chlortetracycline. Data presented in Table 1 show the uptake of this antibiotic by raw whole butterfish and raw scrod steaks. These fish were treated with either a 10-minute dip in a fresh or sea water solution containing 10 p.p.m. chlortetracycline or a 22% freezing brine having 10 p.p.m. chlortetracycline. The abbreviation "CTC" will be used throughout the tables for the antibiotic chlortetracycline.

Additional data presented in Table 1 show the uptake of antibiotic by 8 species of fish which were treated with chlortetracycline ice or with a dip in combination with the prepared ice. The ice containing 5 p.p.m. chlortetracycline was made according to the method described by Upham *et al. (14)*. All residual antibiotic levels were determined on raw fish.

[a] The trademark of American Cyanamid Company for the antibiotic chlortetracycline is Aureomycin.

[b] Presented at the Gulf and Caribbean Fisheries Institute, Miami, Florida, October 31-November 4, 1955.

TABLE 1

Aureomycin chlortetracycline uptake by fish from dip, freezing brine, ice, or ice in combination with dip

Fish	Treatment		Aureomycin Chlortetracycline γ/g. fish
	Dip	Ice	
Scrod	CTC (10 p.p.m.) tap water	Regular	5.50
	CTC (10 p.p.m.) sea water	Regular	4.50
	Freezing brine 22% + CTC (10 p.p.m.)	Regular	3.50
Butterfish	CTC (10 p.p.m.) tap water	Regular	1.33
	CTC (10 p.p.m.) sea water	Regular	0.40
	Freezing brine 22% + CTC (10 p.p.m.)	Regular	0.82
Sea bass	None	CTC (5 p.p.m.)	0.43
	CTC (5 p.p.m.) sea water	CTC (5 p.p.m.)	1.55
Butterfish	None	CTC (5 p.p.m.)	0.54
	CTC (5 p.p.m.) sea water	CTC (5 p.p.m.)	0.98
Porgy	None	CTC (5 p.p.m.)	0.50
	CTC (5 p.p.m.) sea water	CTC (5 p.p.m.)	1.58
Weakfish	None	CTC (5 p.p.m.)	0.05
	CTC (10 p.p.m.) sea water	CTC (5 p.p.m.)	1.60
	CTC (10 p.p.m.) tap water	CTC (5 p.p.m.)	0.88
Croaker	None	CTC (5 p.p.m.)	0.30
	CTC (10 p.p.m.) sea water	CTC (5 p.p.m.)	0.30
	CTC (10 p.p.m.) tap water	CTC (5 p.p.m.)	0.26
Scrod (Boston)	None	CTC (5 p.p.m.)	2.40
Scrod (New Bedford)	None	CTC (5 p.p.m.)	0.91
Salmon	None	CTC (5 p.p.m.)	0.09
Halibut	None	CTC (5 p.p.m.)	0.80

Microbial counts and organoleptic observations were carried out on several species of fish to determine the extension of storage life obtained with chlortetracycline. Those investigated include sea bass, weak fish, croaker, scrod, salmon and halibut. All showed the beneficial effects of chlortetracycline.

Sea bass from the coast of New Jersey were packed in chlortetracycline ice, regular ice, and were also dipped 30 minutes in sea water containing 5 p.p.m. chlortetracycline prior to packing in chlortetracycline ice. These fish were delivered to the laboratory and were held on regular ice throughout the storage period. Microbial counts and organoleptic observations, which are given in Table 2, indicate that the chlortetracycline dip in conjunction with the chlortetracycline ice was most effective.

Weak fish and croakers were also dipped and iced off the New Jersey coast. For this trial, dips were prepared with 10 p.p.m. chlortetracycline in both sea and fresh water. Some fish were dipped for 20 minutes and were then iced with chlortetracycline ice; others were placed directly on chlortetracycline ice or on regular ice. All treated fish were held in the laboratory on chlortetracycline ice, and controls were held on regular ice. The effectiveness of this antibiotic in extending the storage period of freshly caught weak fish and croakers was clearly shown in this experiment (Table 2). The storage life of both species of fish was extended from the 8th to the 15th day by chlortetracycline ice alone or in combination with the dip; no significant difference in odor or microbial count could be detected between fish dipped in sea water or fresh water preparations of the antibiotic.

Scrod from New Bedford, Massachusetts, were iced on shipboard with either chlortetracycline ice or regular ice. The samples were frozen at the dock and then sent to the laboratory. After thawing they were kept on their respective ices throughout the storage period. The data in Table 2 show that chlortetracycline ice was effective in extending the freshness of scrod as evidenced by organoleptic findings and microbial counts from the 22nd to the 36th day after thawing.

Scrod from Boston, Massachusetts evidenced a simi-

TABLE 2

Effect of Aureomycin chlortetracycline on fish freshness[1]

Fish	Treatment		Total Microorganisms x 10^6/g. fish (days)									
	Dip	Ice	1st	4th	7th	8th	11th	12th	13th	15th	16th	18th
Sea bass	None	Regular		980.0 C	8200 A		17,000 A					
	None	CTC (5 p.p.m.)		28.0 E	1700 C		11,000 A					
	CTC (5 p.p.m.) sea water	CTC (5 p.p.m.)		1.4 E	770 D		840 A					
Weakfish	None	Regular	0.013 E	0.35 E		14.0 D	132.0 C			452.0 B		636.0 B
	None	CTC (5 p.p.m.)	0.038 E	0.14 E		1.7 E	5.4 E			15.6 C		58.4 C
	CTC (10 p.p.m.) sea water	CTC (5 p.p.m.)	0.032 E	0.10 E		0.6 E	2.7 E			12.4 D		64.0 C
	CTC (10 p.p.m.) tap water	CTC (5 p.p.m.)	0.054 E	0.51 E		0.5 E	3.2 E			15.2 D		80.8 C
Croaker	None	Regular	0.064 E			5.6 E				240.0 C		320.0 B
	None	CTC (5 p.p.m.)	0.032 E			1.4 E				23.2 D		39.6 C
	CTC (10 p.p.m.) sea water	CTC (5 p.p.m.)	0.040 E			0.852 E				15.6 D		10.5 D
	CTC (10 p.p.m.) tap water	CTC (5 p.p.m.)	0.021 E			0.788 E				11.8 D		10.9 D
Scrod (New Bedford)	None	Regular				0.012 E				8.4 E		
	None	CTC (5 p.p.m.)				0.003 E				0.03 E		
Scrod (Boston)	None	Regular						0.23 E			3.6 E	
	None	CTC (5 p.p.m.)						0.006 E			0.021 E	
Salmon	None	Regular							28.4 D		91.6 C	
	None	CTC (5 p.p.m.)							0.59 E		0.74 E	
Halibut	None	Regular							12.4 B		95.6 B	
	None	CTC (5 p.p.m.)							0.12 E		0.15 E	

Fish	Treatment		Total Microorganisms x 10^6/g. fish (days)									
	Dip	Ice	19th	20th	21st	22nd	25th	26th	28th	29th	36th	
Sea bass	None	Regular										
	None	CTC (5 p.p.m.)										
	CTC (5 p.p.m.) sea water	CTC (5 p.p.m.)										
Weakfish	None	Regular										
	None	CTC (5 p.p.m.)										
	CTC (10 p.p.m.) sea water	CTC (5 p.p.m.)										
	CTC (10 p.p.m.) tap water	CTC (5 p.p.m.)										
Croaker	None	Regular			320.0 B		552.0 B					
	None	CTC (5 p.p.m.)			61.6 B		56.0 B					
	CTC (10 p.p.m.) sea water	CTC (5 p.p.m.)			47.2 C		128.0 B					
	CTC (10 p.p.m.) tap water	CTC (5 p.p.m.)			28.8 C		43.0 B					
Scrod (New Bedford)	None	Regular				14.4 D				520.0 C	884.0 A	
	None	CTC (5 p.p.m.)				2.6 E				20.8 E	30.8 D	
Scrod (Boston)	None	Regular	20.0 D			102.0 B	484.0 A					
	None	CTC (5 p.p.m.)	0.044 E			0.96 E	7.5 E		45.2 E			
Salmon	None	Regular		424.0 A		712.0 A						
	None	CTC (5 p.p.m.)		4.8 D		40.8 C		73.2 B				
Halibut	None	Regular		652.0 A		920.0 A						
	None	CTC (5 p.p.m.)		3.0 D		69.2 C		108.0 A				

[1] Letters indicate ratings as follows: A—putrid; B—strong odor; C—medium odor; D—slight odor; E—no off odor.

lar pattern (Table 2) and data show that chlortetracycline ice extended the storage period from the 19th to the 28th day.

Troll-caught king salmon were obtained at Neah Bay in the state of Washington. These fish were iced with either chlortetracycline ice or regular ice and were shipped across the continent through the usual commercial channels. They were in transit 13 days with one re-icing on the 6th day. Upon arrival in the laboratory the salmon on regular ice had a slight off-odor and were lighter in color with brown discolorations throughout; the salmon on chlortetracycline ice had a fresh odor and a uniform pink color which was retained until the 20th day. The microbial counts and organoleptic findings are presented in Table 2.

Halibut, also obtained in state of Washington waters, were handled in the same manner as the salmon. The control halibut, upon arrival at the laboratory on the 13th day, had a strong odor and the flesh was soft. The halibut kept on chlortetracycline ice had a scarcely detectable off-odor in the gill cavity and the flesh was firm. These treated fish were judged acceptable for eating until the 20th day as shown in Table 2.

SUMMARY

The fresh quality of fish has been successfully prolonged by the antibiotic chlortetracycline applied as an ice, a dip, or a freezing brine. Antibiotic activity has been detected in the raw treated fish, and microbial counts and organoleptic observations have substantiated the effectiveness of chlortetracycline in extending the storage life of freshly caught fish. The fish investigated include sea bass, weak fish, croaker, butterfish, scrod, porgy, salmon and halibut.

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The Detection of Chemical Reactions in Complex Mixtures of Food Antioxidants By Infrared Spectrometry

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In food processing, including treatment of fats and oils with antioxidants, complex mixtures of a considerable number of chemical compounds are frequently involved. It is of vital importance to determine whether reactions among the several components of the complex mixtures have occurred, for only in this way can it be known if a unique combination is concerned in the mechanism of protection of a substrate food material by an additive acting as an antioxidant or inhibitor. It is obvious that chemical analysis of these mixtures of 4, 5, 6, or more compounds, especially when reactions may have occurred between liquids and solids, is not only difficult but unsatisfactory in that the combination may actually destroy the intermediate reaction products for which evidence is sought. Recourse must then be taken to non-destructive instrumental techniques such as x-ray diffraction analysis of crystalline mixtures or optical spectrometric analyses of liquids, liquid-solid systems, or solutions. The effectiveness of the infrared spectrometer is already well known, for the infrared absorption spectra are characteristic for each compound in terms of substituent groups *(1, 2)*. Thus, a careful comparison of absorption bands of various complex mixtures with those of each single pure constituent should provide indisputable evidence of chemical reactions in contrast with simply additive mixtures.

Although the theory and practice of infrared spectrometry are generally familiar, a brief review of the fundamental processes involved in absorption of infrared radiation may aid in the better understanding of its successful application to the analysis of complex antioxidant mixtures. When a quantum of infrared radiation is absorbed by a molecule it excites vibrational motion. The frequency of the absorbed radiation (band center) coincides with the frequency of molecular vibration. Since a molecule may vibrate in a number of different ways, each way has its own frequency; a spectrum consists of a number of absorption bands forming a unique set for each molecule. The spectrum of a mixture, then, corresponds to the superposition of the spectra excited by each species of molecule.

In general, all atoms move when a molecule vibrates. However, vibrations occur in which the major atomic displacements are found concentrated in a small group of atoms. The frequency of such a vibration is characteristic of the group involved plus the type of motion. Thus the "stretching" vibration of a methyl (CH_3) group appears near 3.3 μ (ν 3000), and a "deformation" vibration at 7.0 μ (ν 1430). Group frequencies make possible a qualitative analysis for the presence or absence of various structural units in the molecule. The multiplicity of bands and the specificity with which their locations and intensities are determined by details of molecular structure make the infrared spectrum a veritable "finger print" of molecules in a specimen. Successful identification requires ready accessibility of the infrared spectra of individual compounds. A rapid scanning of a spectrum for absorption bands in regions such as are listed in Table 1 provides a preliminary picture of the structural units present in the specimen. Refinement comes from a detailed examination of the spectrum for band shifts and for confirmatory bands especially in the light of confirmatory evidence as to physical and chemical characteristics of the specimen under investigation.

It is clear, then, that the infrared absorption spectrum as an analytical tool is a property more useful for characterization of a specimen than boiling point, melting point, index of refraction and other familiar measurements, and its relative importance increases with the complexity of the specimen. Ordinarily it is used to prove the identity of two samples and to detect the presence of a specific substance in a mixture. It is a frequent criterion of purity. It is employed for following the recent isolation and purification of such substances as steroids and fluorocarbons. Hydrocarbon mixtures have been analyzed for as many as ten com-

TABLE 1
Scanning of infrared absorption bands

Bands Frequency $cm.^{-1}$	Wave Length, microns	Structural unit
4000-3570	2.5- 3.2	OH, NH, H_2O
3570-3000	3.2- 3.33	Olefines, aromatics
3000-2800	3.3- 3.55	Aliphatics, C-H
2500-2000	4.0- 5.0	Acetylenes, nitriles
2000-1665	5.0- 6.0	Aromatics
1850-1725	5.4- 5.8	Esters, anhydrides, acid halides
1750-1640	5.7- 6.1	Aldehydes, ketones, acids, amides
1335-1000	7.5-10.0	Phenols, alcohols, ethers, esters
910- 665	11.0-15.0	Aromatics, chlorides

ponents, but heretofore no samples as complex as the antioxidants have been attempted or results recorded.

The present system we are reporting represents an unusually complicated one *(3, 4)*. The following substances have been blended together in a wide variety of combinations and proportions in the attempt to prepare an antioxidative additive for foods such as natural and synthetic shortenings: cottonseed or soya bean monoglycerides oil, corn oil as diluent, lecithin, propyl gallate, citric acid, tertiary butyl anisole (BHA), and butyl hydroxytoluene (BHT).

Our investigations and practical tests *(3, 4)* have demonstrated the function and value of these various constituents: propyl gallate (PG) is a highly effective antioxidant for increasing the storage life of fats; butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are used to provide protection through and after baking, the mixture of both being more effective than either compound separately; citric acid has a dual role in sequestering trace metals such as iron and copper which are effective oxidation catalysts, and in synergistically increasing the antioxidant effectiveness of the mixture of PG, BHA, and BHT. As indicated later, lecithin acts to solubilize in oils and fats PG and citric acid which otherwise possess very limited solubility. Each of these individual compounds has been investigated as a liquid smear, or as a powdered solid in an appropriate mull or in KBr disks in order to have a standard infrared spectrum, automatically recorded by the Perkin-Elmer double-beam infrared spectrometer. The comparatively new technique—blending 1% of a sample with 99% powdered pure KBr and compressing in a disk, which is balanced in the spectrometer against a disk of pure KBr, thus eliminating all KBr effects in the spectra—has been particularly successful in this investigation. The mixtures were then examined in the same way. In Figure 1 is shown a typical infrared curve for No. 15, a mixture of six components, while in Table 3 are assembled the data on absorption band frequencies, cm^{-1}, in this spectrum for No. 15, with the probable origin, and for comparative purposes to show characteristic differences in composition and structure the absorption band frequencies for individual conwhich are responsible for the characteristic absorption. stituents and for two other blends, No. 13 and No. 14. The bands for No. 15 are numbered 1 to 26 in the table and corresponding or overlapping bands in the other samples are designated by these numbers. From these numerical values, of course, the infrared spectra can be directly reconstructed. The purpose here is to illustrate only typical data selected from more than a hundred infrared spectra of specimens of single constituents and various combinations of two up to seven original constituents. The compositions of these three blends, No. 13, No. 14 and No. 15 are given in Table 2.

TABLE 2

Composition of 3 antioxidant blends

	No. 13	No. 14	No. 15
Cottonseed oil (monoglyceride)	18	28	—
Corn oil	60.4	59	—
Soybean oil	—	—	46.6
Butyl hydroxytoluene (BHT)	—	—	20.0
Butyl hydroxy anisole (BHA)	13.32	—	3.0
Citric acid	5.0	7	3.5
Propylgallate	3.34	6	4.4
Lecithin	—	—	22.5

Conclusions

From the infrared observations and data, the following conclusions can be drawn:

1. The spectra are sensitive indicators of composition and of chemical change; each blend is unique so that any two specimens yielding the same spectrum must be alike, and any differences in components or in relative proportions of components will immediately be characterized by reproducible differences in spectra.

2. Blends No. 14 (without BHA) and No. 13 (with BHA) and with variation in percentage of other materials, can be easily distinguished from each other and from No. 15, an effective and successful commercial food antioxidant.

3. Table 3 shows that some absorption peaks appear for the mixtures which are not present for the individual constituents, while many characteristic minima for the latter do not appear in the blends. For example, only 6 of the 32 absorption bands for citric acid, only one having strong intensity, appears to correspond with bands for Blend No. 15. Even in the complete absence of excess citric acid in the blend these bands could be produced by substituent groups in other constituents

4. There is good evidence that citrates especially lecithin citrate *(1)* in No. 15 are formed in these systems

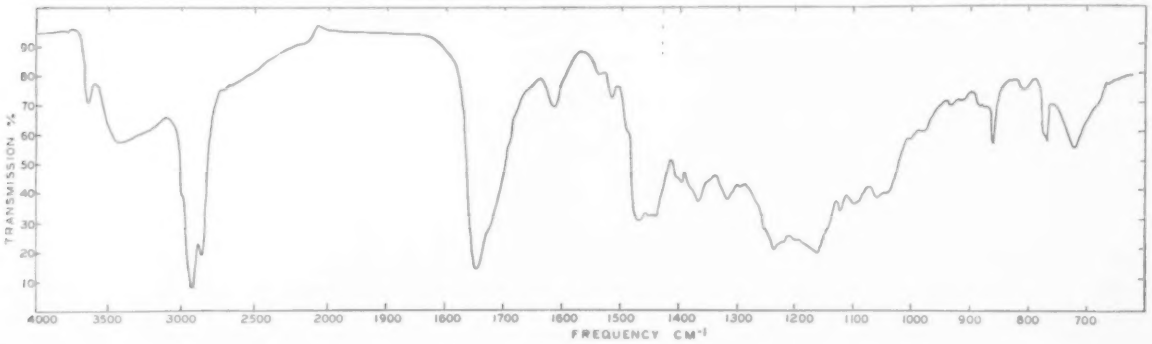

Figure 1

TABLE 3

Frequencies, ν cm^{-1} of infrared absorption bands and relative intensities (w = weak, m = medium, s = strong) for antioxidant blend No. 15 compared with band frequencies of individual constituents and two different blends.

Interpretation of Figure 1										
No. 15	Probable Origin	No. 13	No. 14	BHA	BHT	Lecithin	Propyl Gallate	Citric Acid	Corn Oil	Soybean Oil
(1) 3640 m	C-OH	3460 s	(2) 3440 m	(2) 3400 s	(1) 3620 s	3340 s	(2) 3440 w	3500 m	3000 w	3450 s
(2) 3420 s	C-OH	(3) 2925 s	(3) 2920 s	(3) 2930 s	(2) 3440 w	3000 w	3280 m	3450 w	(3) 2920 s	(3) 2920 s
(3) 2925 s	C-C (aliphatic)	2845 w	2850 w	2860 w	3340 w	(3) 2925 s	2900 br. s	3280 s	2860 w	2800 w
(4) 2875 w	C-C	(5) 1745 s	2330 vw	1600 w	(3) 2925 s	2860 w	1700 s	2920 s	2380 w	(5) 1740 s
(5) 1745 s	ester	(6) 1620 m	2360 vw	(8) 1510 m	1785 w	(5) 1745 s	(6) 1615 s	2860 w	(5) 1750 s	(6) 1620 w
(6) 1620 m	aromatic	1595 m	(5) 1745 s	1425 m	1760 m	1650 w	(7) 1545 s	2650 w	1660 w	(7) 1540 w
(7) 1530 w	C-N-H	(7) 1540 m	(6) 1620 m	(11) 1385 m	1607 m	(9) 1470 s	(9) 1470 s	2560 w	(9) 1470 s	(9) 1470 m
(8) 1515 w	aromatic	(8) 1515 ms	1595 w	(12) 1370 w	(9) 1487 w	1425 w	1415 s	1755 s	1425 w	(13) 1325 w
(9) 1470 s	C-C	(9) 1470 s	(7) 1540 w	1350 w	1460 w	1405 w	(13) 1310 s	1705 s	1405 w	1215 m
(10) 1445 w	C-OH	1430 m	(8) 1515 m	1295 w	(10) 1440 s	(11) 1385 m	1320 m	1460 w	(11) 1385 m	1135 w
(11) 1395 w	CH_2-OH	(12) 1370 s	(9) 1470 s	1285 w	1400 m	(14) 1235 w	1260 s	(10) 1440 m	1245 m	1050 m
(12) 1365 m	tert. alc.	1295 w	1430 w	1260 w	(12) 1370 m	(16) 1170 w	1200 s	(11) 1395 w	(16) 1170 s	995 w
(13) 1320 m	C-OH	1200 m	(11) 1385 w	(14) 1235 m	(13) 1310 s	(19) 1065 m	1105 m	(12) 1365 w	(17) 1125 w	(26) 720 m
(14) 1235 w	ester	(18) 1105 w	(12) 1370 w	1205 s	1270 w	925 w	1045 s	1340 w	1105 m	
(16) 1160 m	ester	(19) 1060 m	1295 w	1190 w	1255 w	825 w	1000 s	(13) 1325 w	1075 sharp	
(17) 1125 w	sec., alc.	1000 w	1180 w	1140 w	(14) 1237 s	(26) 720 s	945 w	1315 w	915 w	
(18) 1100 w	primary alc.	920 w	(17) 1125 w	1050 sharp	1220 m		915 w	1300 w	(26) 720 s	
(19) 1060 w	C-OH	880 m	(18) 1105 w	1040 m	1205 w		880 w	1250 s		
(20) 980 w	aromatic	(23) 860 w	1080 w sharp	1025 w	(16) 1157 s		(23) 865 s	1225 m		
(21) 935 w	aromatic	(24) 805 m	(19) 1060 m	(21) 935 w	(17) 1125 m		815 m	1205 w		
(22) 890 w	aromatic	770 w	(21) 935 w	920 m	1030 m		(25) 790 m	1185 s		
(23) 860 m	p-benzene	760 m	920	880 w	950 w		770 s	1150 s		
(24) 810 w	aromatic	(26) 725 ms	875 m	(23) 860 m	(21) 938 m		750 s	1090 m		
(25) 795 m	aromatic		(23) 860 w	820 s	(22) 890 m		730 s	(19) 1060 m		
(26) 720 m	aromatic		(24) 805 m	770 m	870 s		640 w	950 m		
			770 w	(26) 725 w	825 m			910 m		
			760 m	685 w	770 s			(22) 885 m		
			(26) 725 m		(26) 720 w			820 m		
			695 w					(25) 785 s		
								695 w		
								660 w		
								640 w		

even though water is not present; small amounts of complexes between molecules also must be formed. These new compounds of still uncertain configuration must be responsible for the effective mechanism of antioxidant action. Citric acid and propyl gallate are essentially oil-insoluble but lecithin citrate does dissolve in oil and provides a means for solubilization (through complexing) of propyl gallate.

5. These results confirm the somewhat less sensitive x-ray diffraction method which has indicated a non-additive contribution of liquid and solid phases to diffuse patterns of haloes.

6. It has been impossible thus far by methods of selective extraction or chromatography to separate and recover quantitatively original constituents of blends, a further indication of chemical combinations in the blends.

7. Oxygen is absorbed by these mixtures and the infrared spectra show the presence of carboxyl, hydroxyl and aldehyde groups in bands of characteristic wave lengths, with disappearance or diminution of original absorption minima.

8. The infrared spectra by their very nature in detecting types of bonds and substituent groups from their vibrations (bond stretching) and rotation in organic molecules do not identify positively every molecular species in a complex blend such as these antioxidants. Such an identification would prove extremely difficult if not impossible. The present work has certainly demonstrated the sensitivity, and the unique characterization of each single constituent and of their combinations, and reactions to form new individuals. The spectra demonstrate the mechanism of antioxidant action in selectively removing and combining with oxygen which then cannot oxidize the oily or fatty shortening with consequent rancidity from acid and aldehyde formation.

SUMMARY

Infrared spectrometry has been used as a modern instrumental technique of characterizing complex mixtures of as many as seven constituents in effective food antioxidants with comparison of data for three typical blends with the absorption band frequencies for the individual constituents. It is demonstrated that the infrared spectrum is highly characteristic for each blend and that there is clear evidence of reactions among the constituents such as the formation of lecithin citrate.

Acknowledgment

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Effect of Sucrose and Organic Acids on Apparent Flavor Intensity II. Fruit Nectars

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PREVIOUS INVESTIGATORS *(7, 14)* have shown that sweetness influences apparent flavor intensity of aqueous solutions. When presented with solutions of distilled water containing sucrose, acid, and imitation raspberry flavoring, judges ascribed more flavor to the sweeter sample, up to 15% sucrose *(14)*. In the present investigation, fruit nectars were studied to determine the sweetness-acid-flavor relationship in a natural food product.

The statement has been made, "There is no evidence that a direct relationship exists between sensitivity to the taste of chemically pure solutions and ability to detect flavors in food products" *(3)*. Mackey and Jones *(9)* believe that the tasting situation for foods is different from that of water solutions, being complicated by the various taste and odoriferous substances present, and by the texture of the food. They state further that the complexity of the food judging situation makes it probable that the primary tastes will be harder to detect in foods than in water solutions. Their experiments showed that the taste panel was able to arrange, with high accuracy, water solutions and foods (pureed applesauce, pureed pumpkin, and mayonnaise) according to concentration of the added taste substances.

Flavor and sweetness are closely related factors, especially in fruit products. In fact, Sjöström and Cairncross *(12)* consider the sweet taste a flavoring. Their laboratory has found sucrose to be predominant in the flavor of strawberry preserves *(13)*, frozen peaches *(4)*, red raspberries and blackberries *(5)*. The added sucrose counteracted some of the inherent sourness and enhanced the natural fruit character.

The relationship of sweetness with flavor has been demonstrated with foods other than fruits. Sucrose added at low concentrations to peas, corn, carrots, mashed potatoes, tomato products and even canned meats and sea foods, improved the blending of the various flavor components *(6, 12)*. In many instances this blending was accompanied by an increase in total flavor.

In view of the work summarized above and considering previous results collected by this laboratory *(11, 14, 15)*, the present study involving nectars, was conducted with the following in mind: (a) that there exists a level at which added sucrose ceases to enhance flavor, and (b) that the relationship between sweetness and flavor is influenced by acidity.

METHODS AND MATERIALS

Raw materials. The fruit nectars were made from Blenheim apricots, Bartlett pears, and Halford cling peaches. All nectars consisted of 55% fruit and 45% water by weight with no added syrup. The raw fruit was put through a 0.033 screen in a Lasencamp pulper, blended with water, then poured into No. 2½ size cans. Cook times were 40 minutes at 210° F., 32 minutes at 210° F., and 40 minutes at 212° F., for the apricot, pear, and peach nectars, respectively. The chemical analyses of the natural fruit nectars are summarized in Table 1.

TABLE 1

Chemical and physical characteristics of fruit nectars

Nectar	Soluble-solids[1]	pH	Acid as % citric anhy.	Soluble-solids acid ratio
Apricot	9.74	3.80	0.592	18.41
Pear	8.48	4.15	0.103	82.33
Peach	10.93	3.92	0.364	30.03

[1] Recorded as degrees Brix by refractometry.

Taste panel. A laboratory taste panel of 16 to 22 judges, selected on the basis of their ability to detect small differences in concentrations of sucrose and acid in nectars, evaluated the nectar samples over a period of 3 months. The samples were always tasted at mid-morning and at room temperature (78° F.) in booths especially designed for organoleptic analysis. Judges were given the correct responses after each tasting session.

Design of experiment. *Method of paired comparison.* For the apricot nectar only, the method of paired comparison was used, wherein judges received 4 pairs of samples at each tasting session and were asked to state whether the first sample in each pair appeared to have more, less, or the same flavor intensity as the second sample. Judges also recorded their preferences. Each pair consisted of any two of the possible combinations of sweetness (0%, 4% or 8% sucrose) with acid (0.0%, 1.0%, 1.1% or 1.4%)[a] and/or flavoring (0.0% and 1×10^{-6} % commercial apricot flavoring).[b] The synthetic flavoring, added for control purposes, was too low to alter the flavor seriously. The possibility of receiving identical samples was also included. Chemical analyses of the sweetened and/or acidified apricot nectar are presented in Table 2.

The order in which the samples were presented within a pair and the order in which the 4 pairs were arranged within a set was randomized. Each combination was served in the reverse order one-half of the time to off-set the natural bias for the first samples presented *(1, 2, 11)*. A total of 16 evaluations was obtained for each of the possible combinations.

Method of multiple comparison. In order to more clearly separate the flavor and sweetness factors, a multiple comparison method was used. Employing a randomized complete block design, sets of 4 samples of sweetened and/or acidified apricot, pear and peach nectars were presented to the same panel of judges. At each tasting session, the panel members received 4 samples containing approximately 30 ml. of nectar in coded beakers. Each sample differed in sucrose content (between 4% and 12%) and/or added citric acid (between 0.5% and 1.5%). The chemical characteristics of these fruit nectars are given in Table 3.

TABLE 2

Chemical analyses of the sweetened and/or acidified apricot nectar used in paired comparisons

Sample		Soluble-solids (° Brix)	pH	Acid as % citric anhy.	Soluble-solids acid ratio
Sucrose[1]	Acid[2]				
%	%				
0.0	1.0	9.83	3.50	0.788	12.47
4.0	0.0	13.24	3.70	0.573	23.11
4.0	1.1	13.24	3.52	0.777	17.04
8.0	0.0	16.64	3.80	0.552	30.14
8.0	1.4	16.64	3.47	0.794	20.96

[1] Percent by weight.
[2] Mixture of succinic, tartaric, citric and malic acids.

[a] A mixture of succinic, tartaric, citric and malic acids in a ratio of 1:2:6:11, respectively.

[b] Imitation apricot elements (Magnus, Mabee & Reynard, Inc., New York).

TABLE 3

Chemical analyses of sweetened and/or acidified nectars

Combinations		Soluble solids[1]	pH	Total acidity[2]	Soluble solids-acid ratio
Sucrose	Acid				
Apricot Nectar					
%	%			%	
4.0	0.0	13.48	3.98	0.576	23.41
6.0	0.0	15.10	3.97	0.571	26.44
7.0	0.0	15.88	3.94	0.590	27.94
8.0	0.0	16.69	3.97	0.556	30.02
9.0	0.0	17.55	3.89	0.555	31.63
10.0	0.0	18.27	3.95	0.544	33.62
10.0	0.2	18.06	3.78	0.725	24.91
10.0	0.4	17.96	3.60	0.896	20.04
12.0	0.2	19.56	3.80	0.712	27.47
12.0	0.4	19.36	3.58	0.880	22.00
Pear Nectar					
6.0	0.0	13.60	4.40	0.102	133.75
8.0	0.0	15.48	4.15	0.097	159.59
9.0	0.0	16.29	4.15	0.096	169.69
10.0	0.0	17.00	4.15	0.095	178.95
11.0	0.0	17.70	4.15	0.095	186.32
12.0	0.0	18.45	4.16	0.093	198.38
Peach Nectar					
4.0	0.0	14.41	3.98	0.344	41.89
6.0	0.0	16.13	3.95	0.347	46.43
6.0	1.0	15.89	3.98	0.448	35.40
7.0	0.0	16.74	3.92	0.340	49.24
7.0	1.5	16.93	3.68	0.485	34.91
8.0	0.0	17.61	3.97	0.338	52.06
8.0	1.0	17.58	3.87	0.436	40.30
9.0	0.0	18.47	4.01	0.339	54.49
9.0	1.0	18.36	3.63	0.425	43.22
9.0	1.5	18.27	3.75	0.465	39.25
9.0	2.0	18.30	3.76	0.504	**36.31**
10.0	0.0	19.19	3.93	0.334	57.54
10.0	1.0	19.08	3.84	0.429	44.50
11.0	1.0	19.67	3.86	0.422	46.65
12.0	0.0	20.66	3.97	0.331	62.30
12.0	1.0	20.55	3.88	0.420	49.00

[1] Recorded as ° Brix by refractometry.
[2] Recorded as % citric.

The judges were requested to answer four questions concerning the nectars within each set of four, namely: (a) Which is the sweetest sample?, (b) Which sample has the most fruit flavor? (c) Which sample do you like most? and (d) Which sample do you like least? This type of score sheet made it possible to determine any relationship existing between fruit flavor and sweetness. It also enabled the judges to express their preferences and made it possible to ascertain the accuracy and consistency of the panel.

RESULTS AND DISCUSSION

Method of paired comparison. Flavor responses and preferences for sweetened and/or acidified apricot nectar evaluated by the method of paired comparison are summarized in Table 4. In part (a), when the control was compared with nectar containing 4% or 8% sucrose, a very highly significant[c] number of responses ascribed more flavor to the sweeter sample. In addition, there was a very decided preference for the nectar with the greater amount of sucrose. Although the above-mentioned trend was apparent when the 8% sucrose sample was compared directly against the nectar containing 4% sucrose, the difference was not statistically significant.

Addition of organic acids appeared to balance the sweetness and thereby enhanced the flavor of the sweetened nectars to a significant degree [part (b)]. In unsweetened nectars, however, the addition of acid decreased apparent flavor intensity by unbalancing this sweetness-acid relationship.

Responses to the addition of both sucrose and acid indicated a significant tendency to ascribe more flavor to the sample with the greater SS/A,[d] as shown in part (c). In this type of comparison, the following ratios were preferred: 17.04 over 12.47; 20.96 over 12.47; and 20.96 over 17.04.

In general, sucrose, in the percentages employed in this investigation, enhanced natural apricot flavor. Addition of organic acids increased palatability, especially when accompanied by the addition of sucrose. Preference appeared to be based on sweetness and on acidity as well as on the ratio of these two factors.

The accuracy of the judges was tested by interspersing identical paired samples at random among the other combinations. The number of correct responses was significant at the 0.001% level of probability when these identical samples were tasted.

Method of multiple comparison. *Apricot Nectar.* Responses obtained from the multiple comparison of sweetened and/or acidified apricot nectars are presented in Table 5. When samples containing 4, 6, 8 or 10% added sucrose were directly compared (Series I), the 8% sucrose sample appeared to be the most flavorful and was preferred most frequently. The panel was unable to discriminate among samples, in reference to flavor and preference, when the sucrose increments were reduced to 1% (6, 7, 8 or 9% sucrose). When the nectars were acidified (Series III), diversified opinions were obtained from the panel. Results show that the three nectars with the higher SS/A were liked most,

TABLE 4

Effect of sucrose and/or acid on flavor response and preference for apricot nectar (paired comparisons)

(a) Effect of addition of sucrose on flavor response

Comparisons[1]				Flavor response with reference to Sample A			Preference	
Sample A		Sample B						
Sucrose	Acid	Sucrose	Acid	Same	More	Less	A	B
%	%	%	%	%	%	%	%	%
4.0	0.0	0.0	0.0	6.2	78.2***	15.6	84.3***	15.7
8.0	0.0	0.0	0.0	6.2	74.8***	19.0	90.6***	9.4
8.0	0.0	4.0	0.0	21.9	47.1	31.0	64.0	36.0

(b) Effect of addition of organic acids on flavor responses

Comparisons[1]				Flavor response with reference to Sample C			Preference	
Sample C		Sample D						
Sucrose	Acid	Sucrose	Acid	Same	More	Less	C	D
%	%	%	%	%	%	%	%	%
0.0	1.0	0.0	0.0	43.8	28.1	28.1	30.0	70.0*
4.0	1.1	4.0	0.0	19.0	50.0*	31.0	67.1	32.9
8.0	1.4	8.0	0.0	12.5	53.2*	34.3	56.1	43.9

(c) Effect of addition of sucrose and acid on flavor responses

Comparisons[1]				Flavor response with reference to Sample E			Preference	
Sample E		Sample F						
Sucrose	Acid	Sucrose	Acid	Same	More	Less	E	F
%	%	%	%	%	%	%	%	%
4.0	1.1	0.0	1.0	12.5	71.9***	15.6	90.6***	9.4
8.0	1.4	0.0	1.0	9.4	65.6***	25.0	89.0***	11.0
8.0	1.4	4.0	1.1	15.7	53.3*	31.0	70.3*	29.7

[1] Each pair evaluated 32 times.
*Sig. at P = 0.05. **Sig. at P = 0.01. ***Sig. at P = 0.001.

[c] Significance determined by method developed by Roessler, Baker and Amerine *(10)*.

[d] Soluble solids-acid ratio.

TABLE 5

Effect of sucrose and/or citric acid on flavor and preference for apricot nectar (multiple comparison)[1]

Series	Samples compared		SS/A[2]	Judges' responses			
	Added sucrose	Added acid		Sweetest sample	Most apricot flavor	Liked most	Liked least
	%	%		%	%	%	%
I	4	0	23.41	0.0	2.4	0.0	66.0***
41	6	0	26.44	0.0	27.0	27.0	9.8
evaluations	8	0	30.02	2.4	53.7**	51.2*	2.4
	10	0	33.62	97.6***	16.9	21.8	21.8
II	6	0	26.44	2.1	19.0	19.0	42.5
47	7	0	27.94	4.3	30.0	27.6	23.4
evaluations	8	0	30.02	12.8	23.4	23.4	8.5
	9	0	31.63	80.8***	27.6	30.0	25.6
	8	0.0	30.02	26.0	26.2	26.0	36.7
III	10	0.2	24.91	3.2	20.8	21.0	6.7
31	10	0.4	20.04	0.0	16.1	16.1	33.3
evaluations	12	0.2	27.47	50.0*	16.1	20.8	6.7
	12	0.4	22.00	20.8	20.8	16.1	16.6

[1] Randomized complete block design. [2] Soluble solids-acid ratio. *Sig. at P = 0.05; **Sig. at P = 0.01; ***Sig. at P = 0.001.

but the lowest and highest SS/A within each series were liked least. Preference could be based primarily on the highest apparent flavor intensity. The intensity of the natural fruit flavor is, in turn, dependent upon an optimum soluble solids content in proportion to an optimum acidity. For apricot nectar, these optimum values were 16° to 18° Brix for the soluble solids and 0.56 to 0.59% acid.

Pear Nectar. The judges' responses to sweetened pear nectar (Table 6) show a trend similar to that of

TABLE 6

Effect of sucrose on flavor and preference for pear nectar (Multiple comparison)[1]

Series	Samples compared	SS/A[2]	Judges' responses			
	Added sucrose		Sweetest sample	Most pear flavor	Liked most	Liked least
	%		%	%	%	%
I	6.0	133.75	0.0	5.0	5.0	60.0***
40	8.0	159.59	2.4	50.0*	45.0	7.5
evaluations	10.0	178.95	4.9	37.5	37.5	2.5
	12.0	198.38	92.7***	7.5	12.5	30.0
II	8.0	159.59	1.8	33.3	29.8	36.8
57	9.0	169.69	5.3	31.7	31.7	8.8
evaluations	10.0	178.95	10.5	17.5	21.0	12.3
	11.0	186.32	82.4***	17.5	17.5	42.1

[1] Randomized complete block design.
[2] Soluble solids-acid ratio.
*Sig. at P = 0.05. **Sig. at P = 0.01. ***Sig. at P = 0.001.

the apricot nectar. There was a highly significant[6] degree of accuracy in identification of the sweetest sample in all series; a dislike for the least sweet nectar; association of preference with the most flavorful sample; and correlation of flavor and preference with the soluble solids-acid ratio. Pear nectar with a ratio between 159 and 169 was the most liked.

Peach Nectar. A more extensive survey with peach nectar produced interesting results (Table 7). When the 4 samples presented consisted of 4, 6, 8 or 10% sucrose, the panel designated the 8% sucrose level as the most flavorful as well as the most liked. This result was verified by Series II, where an even narrower sucrose range was used. However, when the samples with sucrose levels of 6, 8, 10 or 12% were evaluated (Series III), preference shifted toward the 10% level. This is consistent only with their tendency to prefer the second sweetest sample in each series of four (Series I and II).

The effect of adding citric acid on the responses is presented in Series IV, V, VI and VII. It is of interest to note, in comparing Series III with IV, that the addition of acid did not produce a shifting of preference to a SS/A approximating the one originally preferred as might be expected. Instead, the judges responded to the acidified nectars in much the same manner as to the unacidified samples, placing them in the same relative order.

To elaborate on the data collected from comparisons in the fourth series, the sucrose range was narrowed (Series V) and resulted in a general liking for the nectar containing 10% sucrose (SS/A of 44.50).

Various levels of citric acid were added to the peach nectar in Series VI and VII. The samples containing 9% sucrose and acidified with 1.5% acid were the best liked in each of these series. This particular nectar had a SS/A of 39.25.

SUMMARY

Apricot, peach, and pear nectars were evaluated by a trained taste panel to determine the relationship that exists between fruit flavor, sweetness, and acidity. Previous results had led to the conclusions: (a) that there exists a level at which added sucrose ceases to enhance flavor, and (b) that the relationship between sweetness and flavor is influenced by acidity.

When evaluated by the method of paired comparison, sucrose added at levels of 4 and 8% enhanced natural apricot flavor. Apricot flavor was enhanced even further when organic acids were added to the sweetened nectar. All nectars were evaluated by the method of multiple comparison and the following observations were made: (1) The panel associated preference with the sample they considered most flavorful; (2) apparent flavor intensity seemed to depend upon the ratio of optimum soluble solids and optimum acidity; (3) there was a high degree of accuracy in identifying the sweetest sample in all series; and (4) in general, there was a dislike for the least sweet nectar in each respective series. Preferred soluble solids-acid ratios for

[6] Significance determined by method of X^2 as described by Fisher and Yates (8).

TABLE 7

Effect of sucrose and/or citric acid on flavor and preference for peach nectar (multiple comparison)[1]

Series	Samples compared		SS/A[2]	Judges' responses			
	Added sucrose	Added acid		Sweetest sample	Most peach flavor	Liked most	Liked least
	%	%		%	%	%	%
I	4	0	41.89	0.0	25.6	23.3	65.1***
43	6	0	46.43	2.3	18.6	18.6	6.9
evaluations	8	0	52.06	4.7	41.9	37.2	4.7
	10	0	57.54	93.0***	13.9	20.9	23.3
II	6	0	46.43	1.6	24.6	23.0	55.7***
61	7	0	49.24	6.6	26.2	24.6	9.8
evaluations	8	0	52.06	16.4	27.9	26.2	11.5
	9	0	54.49	75.4***	21.3	26.2	23.0
III	6	0	46.43	0.0	16.3	13.9	53.5**
43	8	0	52.06	0.0	34.9	34.9	9.3
evaluations	10	0	57.54	9.3	39.5	41.9	4.6
	12	0	62.30	90.7***	9.3	9.3	32.6
IV	6	1.0	35.40	2.4	11.9	11.9	69.0***
42	8	1.0	40.30	0.0	35.7	35.7	2.4
evaluations	10	1.0	44.50	9.5	42.9	42.9	7.1
	12	1.0	49.00	88.1***	9.5	9.5	21.5
V	8	1.0	40.30	0.0	14.6	14.6	39.0
41	9	1.0	43.22	4.9	26.8	26.8	24.4
evaluations	10	1.0	44.50	14.6	31.8	31.8	12.2
	11	1.0	46.65	80.5***	26.8	26.8	24.4
VI	7	0.0	49.24	9.8	23.0	21.3	24.6
43	7	1.5	34.91	0.0	19.7	23.0	49.2**
evaluations	9	0.0	54.49	88.5***	18.0	23.0	19.7
	9	1.5	39.24	1.7	39.3	36.1	6.6
VII	9	0.0	54.49	95.2***	17.7	22.6	33.9
62	9	1.0	43.22	3.2	37.1	32.3	9.7
evaluations	9	1.5	39.25	1.6	29.0	42.2	9.7
	9	2.0	36.31	0.0	16.2	20.9	46.7**

[1] Randomized complete block design. [2] Soluble solids-acid ratio. *Sig. at P = 0.05. **Sig. at P = 0.01. ***Sig. at P = 0.001.

apricot, pear and peach nectars were approximately 30, 160 and 40, respectively.

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Notes and Letters

A Quick, Rank Test for Significance of Differences in Multiple Comparisons[a]

THE METHOD PROPOSED is especially suitable where actual values are not particularly meaningful, as in the case of sensory evaluations, where it is convenient, and perhaps even desirable, to rank a series of samples in order of preference, or difference. The method is based on the polynomial distribution with number of treatments (samples) equated to the terms of the polynomial, and number of replications equated to the power. The generalized equation is as follows:

$$(T_1 + T_2 + \ldots\ldots T_n)^{Rn}$$

Thus the probability (P) of the chance occurrence of a rank total for any given treatment (sample) as compared to other treatments, replicated n times, may be determined. Such calculated values are presented in Table 1 for the 1% level of significance (P = .01), and in Table 2 for the 5% level of significance (P = .05). The method of using these tables is illustrated in the following example. Seven samples of tomato juice were processed with different antioxidants. A sensory panel consisting of 7 judges was asked to rank the samples in order of preference in regards to general attractiveness of appearance. The results were as follows:

Judges (replicates)	Treatments (samples)						
	1	2	3	4	5	6	7
A	3	1	4	2	6	5	7
B	2	1	3	4	5	6	7
C	3	1	2	4	5	6	7
D	2	1	4	3	7	6	5
E	2	1	3	4	5	6	7
F	4	1	2	3	6	5	7
G	3	1	2	6	7	5	4
Rank totals	19	7**	20	26	41**	39*	44**

Entering Table 1, we find the values of 16-40 for 7 treatments, and 7 replications. Since the rank total for treatment 2 was only 7, which is lower than 16, it may be concluded that treatment 2 was preferred well beyond the 1% level of significance. Similarly, treatments 5 and 7 were rejected by the panel with more than 99% assurance that the rejection was not due to chance alone. Entering Table 2 for 7 treatments and 7 replications, we find the values of 19-37, indicating that treatment 6 (rank total of 39) was also rejected but only at the 5% level of significance. The difference between the hyphenated values may also be used as a least significant difference. Thus, all treatments above 31 (7 + 24) may be considered to be significantly different from Treatment 2 at the 1% level.

The method need not be limited to the analysis of rank data, since quantified test data may be ranked, and these in turn handled as above. As an example of such a procedure, we may use the scores of the same judges for the same samples of tomato juice. In this case each judge scored each sample on a scale of 10, with one indicating poor appearance, and 10, excellent appearance. The scores were as follows:

Judges	Treatments													
			2		3		4		5		6		7	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
A	6	4.5	10	1	7	2	7	3	5	6.5	6	4.5	5	6.5
B	8	2.5	10	1	8	2.5	7	4	6	5.5	6	5.5	5	7
C	7	2.5	9	1	7	2.5	6	4	4	5	3	6	1	7
D	7	1.5	7	1.5	6	3.5	6	3.5	5	6	5	6	5	6
E	4	4.5	6	1	4	4.5	4	4.5	4	4.5	5	7	3	7
F	7	3	8	1	7	3	7	3	5	6.5	6	5	5	6.5
G	8	4	10	1	9	2.5	6	6	4	7	7	5	9	2.5
Rank totals		22.5		7.5**		20.5		28.0		41.0**		34.0		42.5**
Score totals	47		60		49		43		33		38		33	
means	6.7		8.6		7.0		6.1		4.7		5.4		4.7	

Thus, essentially the same conclusions were obtained from the score data, except that the rejection of treatment 6 was not indicated. This may be an indication that in such situations where differences are to be maximized, ranking may be preferred to scoring not only for the sake of convenience, but to maximize differences as well.

The score data were also analyzed by the standard procedure for the analysis of variance *(1)*, with the following results:

Factors	d/f	Sum of squares	Mean square	F ratio
Treatments	6	80.77	13.46	10.8**
Judges	6	53.92	8.99	7.2**
Treat. × Judge	36	44.66	1.24	
Total	48	179.35		

The Least Significant Difference, as calculated by the method of Duncan, was 1.5 at the 5%, and 2.4 at the 1% levels of significance. When comparing treatment

[a] Scientific Art. No. A557, Contribution No. 2711, of the Maryland Agricultural Experiment Station (Departments of Horticulture and Entomology). Partial support from funds provided under the Research and Marketing Act of 1946, project NE15.

TABLE 1

Rank totals required for significance at the 1% level (P = 0.01). (Rank total must be lower than 1st value or higher than second value to indicate significance. The difference between the values is equivalent to the least siginficant difference.)

Number of replicates	Number of treatments (or samples)										
	2	3	4	5	6	7	8	9	10	11	12
2									3-19	3-21	3-23
3				4-14	4-17	4-20		5-25	6-27	6-30	6-33
4			5-15	6-18	6-22	7-25	8-28	8-32	9-35	10-38	10-42
5		6-14	7-18	8-22	9-26	10-30	11-34	12-38	13-42	14-46	15-50
6		8-16	9-21	10-26	12-30	13-35	14-40	16-44	17-49	18-54	20-58
7	8-13	9-19	11-24	12-30	14-35	16-40	18-45	19-51	21-56	23-61	25-66
8	9-15	11-21	13-27	15-33	17-39	19-45	21-51	23-57	25-63	27-69	30-74
9	10-17	12-24	15-30	17-37	20-43	22-50	25-56	27-63	29-70	32-76	35-82
10	11-19	14-26	17-33	20-40	22-48	25-55	28-62	31-69	34-76	37-83	39-91
11	13-20	16-28	19-36	22-44	25-52	28-60	32-67	35-75	38-83	41-91	44-99
12	14-22	17-31	21-39	24-48	28-56	31-65	35-73	39-81	42-90	46-98	49-107
13	15-24	19-33	23-42	27-51	31-60	35-69	38-79	43-87	47-96	50-106	54-115
14	17-25	21-35	25-45	29-55	33-65	38-74	42-84	46-94	51-103	55-113	59-123
15	18-27	22-38	27-48	32-58	36-69	41-79	46-89	50-100	55-110	60-120	64-131
16	19-29	24-40	29-51	34-62	39-73	44-84	49-95	54-106	59-117	64-128	69-139
17	21-30	26-42	31-54	36-66	42-77	47-89	53-100	58-112	63-124	69-135	74-147
18	22-32	27-45	33-57	39-69	45-81	50-94	56-106	62-118	68-130	73-143	79-155
19	23-34	29-47	35-60	41-73	47-86	53-99	60-111	66-124	72-137	78-150	84-163
20	24-36	31-49	37-63	43-77	50-90	57-103	63-117	70-130	76-144	82-158	89-171

TABLE 2

Rank totals required for significance at the 5% level (P = 0.05). Rank total must be lower than 1st, or higher than 2nd hyphenated value to indicate significance. The difference between the values is equivalent to the least significant difference.)

Number of replicates	Number of treatments (or samples)										
	2	3	4	5	6	7	8	9	10	11	12
2				3-9	3-11	3-13	4-14	4-16	4-18	5-19	5-21
3		4-8	4-11	5-13	6-15	6-18	7-20	8-22	8-25	9-27	10-29
4		5-11	6-14	7-17	8-20	9-23	10-26	11-29	13-31	14-34	15-37
5	6-9	7-13	8-17	10-20	11-24	13-27	14-31	15-35	17-38	18-42	20-45
6	7-11	9-15	10-20	12-24	14-28	16-32	18-36	19-41	21-45	23-49	25-53
7	8-13	10-18	13-22	15-27	17-32	19-37	21-42	23-47	26-51	28-56	30-61
8	10-14	12-20	15-25	17-31	20-36	22-42	25-47	27-53	30-58	33-63	35-69
9	11-16	14-22	17-28	20-34	23-40	26-46	28-53	31-59	34-65	37-71	40-77
10	12-18	15-25	19-31	22-38	25-45	29-51	32-58	35-65	39-71	42-78	45-85
11	14-19	17-27	21-34	24-42	28-49	32-56	36-63	39-71	43-78	47-85	50-93
12	15-21	19-29	23-37	27-45	31-53	35-61	39-69	43-77	47-85	51-93	55-101
13	16-23	21-31	25-40	29-49	34-57	38-66	43-74	47-83	52-91	56-100	61-108
14	18-24	22-34	27-43	32-52	37-61	41-71	46-80	51-89	56-98	61-107	66-116
15	19-26	24-36	29-46	34-56	39-66	45-75	50-85	55-95	60-105	65-115	71-124
16	20-28	26-38	31-49	37-59	42-70	48-80	53-91	59-101	65-111	70-122	76-132
17	22-29	28-40	33-52	39-63	45-74	51-85	57-96	63-107	69-118	75-129	81-140
18	23-31	29-43	35-55	42-66	48-78	54-90	60-102	67-113	73-125	80-136	86-148
19	24-33	31-45	37-58	44-70	51-82	58-94	64-107	71-119	78-131	84-144	91-156
20	25-35	32-48	39-61	46-74	54-86	61-99	67-113	74-126	82-138	89-151	96-164

means in accordance with these L.S.D.'s, the conclusions that may be drawn are quite similar to those obtained by the proposed method.

Other data involving comparisons among lubricants, chemical procedures, sweet corn variety yields, and off-flavors in canned squash, were analyzed by the proposed method and the results were found to be similar to those obtained by the analysis of variance.

Wilcoxon *(3)* reported on a rapid ranking method; however, his rapid procedure is limited to a comparison of two treatments, while for multiple comparisons some additional calculations are required for calculating the X^2. The proposed method is even more rapid than the quick method of analysis from the range reported by Tukey *(2)* when the original data are in rank form, or when the replicate variance is significant, since the ranking procedure automatically eliminates such replicate variations.

AMIHUD KRAMER
University of Maryland

LITERATURE CITED

1. SNEDECOR, G. W. *Statistical Methods.* 4th ed., 1946, Iowa State College Press, Ames.
2. TUKEY, J. W. Trans. N. Y. Acad. Sci. Ser. II, Vol. 16, No. 2, p. 88 (1953).
3. WILCOXON, FRANK. American Cyanamid Co., N. Y. (1949).

(Continued from page 32)

charin and the cyclamates. This valuable report gives a reassuring appraisal of the safety of these sweeteners for special dietary purposes but does not support the unrestricted use of these sweeteners in general purpose foods and beverages.

INDUSTRIAL HEALTH

Investigations into the toxicity of solvents for replacing benzene: II. A study of toluene.

FABRE, R., TRUHAUT, R., LAHAM, S., AND PERON, M. *Arch. maladies profess., med. travail et securite sociale, 16,* 197-215 (1955); *Arch. Ind. Health, 13* (4), 399 (1956).

Experiments were carried out on rats and rabbits exposed to varying concns. of pure toluene vapor for 8 hrs. a day for 6 days a wk. over 7 wks. The findings indicate no alteration in the blood picture regarding red or white cells and no change in general health. Similar expts. with dogs gave similar results and also showed that the bone marrow was in no way modified. Toluene was found to be far less toxic than benzene.

PACKAGING

Strength properties of polyethylene-coated papers.

ARNOLD, K. A. (St. Regis Paper Co., Deferiet, N. Y.). *Modern Packaging, 29* (8), 138-144+ (1956).

New dynamic test methods support field data indicating multiwall bag with polyethylene-coated paper ply has greater shock resistance than conventional paper tests indicate.

PHYSICAL RESEARCH

Method for measuring consistency of foodstuffs.

WOLODKEWITSCH, N. (Bundesforschungsanstalt fur Lebensmittelfrischhaltung, Karlsruhe). *Z. Lebensm. Untersuch. u-Forsch., 103,* 261-72 (1956).

An app. and method are described for measuring consistency by means of a load deformation curve. Good correlation was obtained with subjective tests.

STATISTICS

On some applications of statistics to biological sciences.

Research Today, 11 (2), 27-39 (1956).

An expository article on the design of expts. touching on most of the basic principles. The presentation is exceptionally good and very readable. The principles are illustrated by presenting the statistical analysis of some exptl. results.

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(Continued on page 38)

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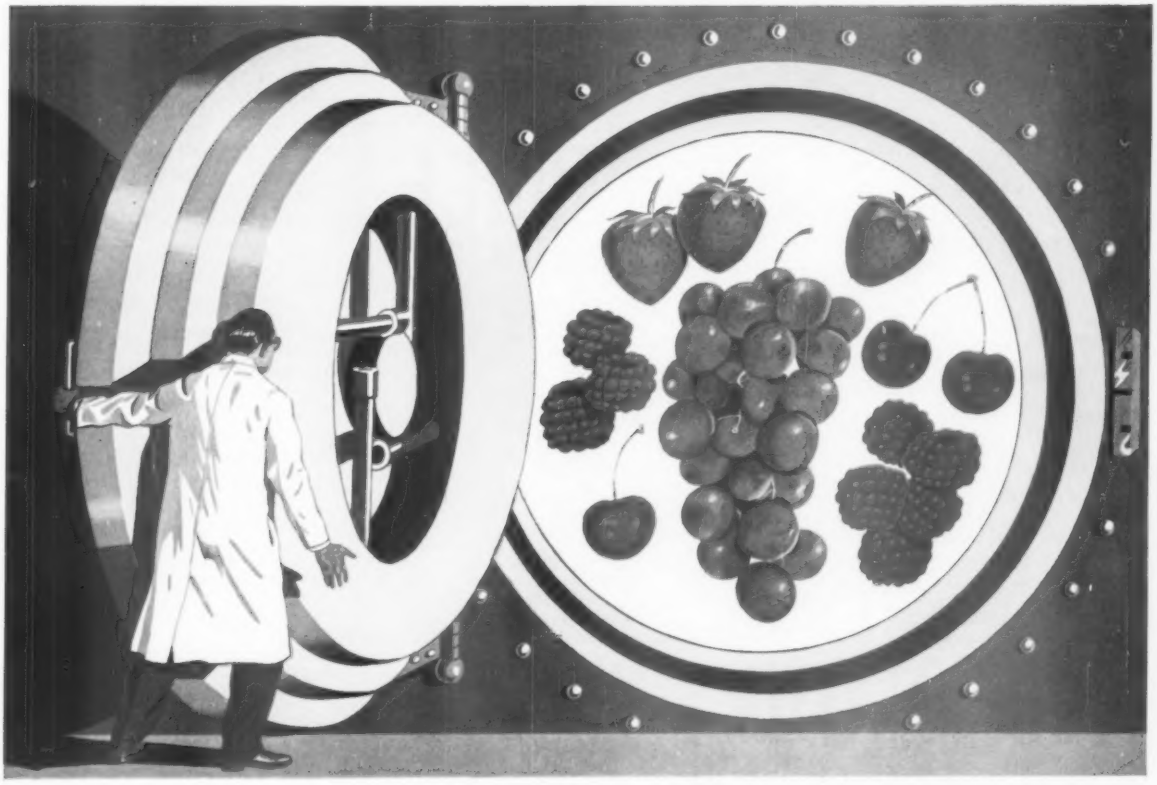

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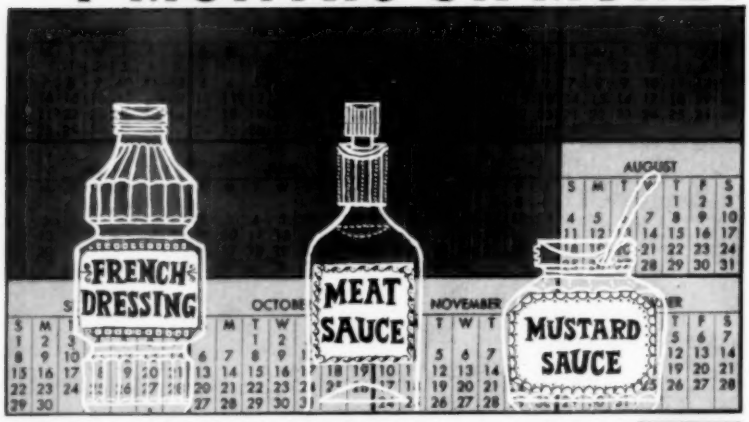

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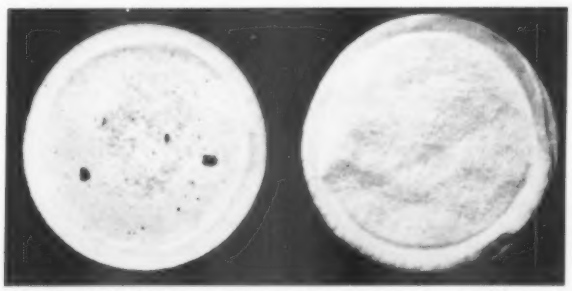

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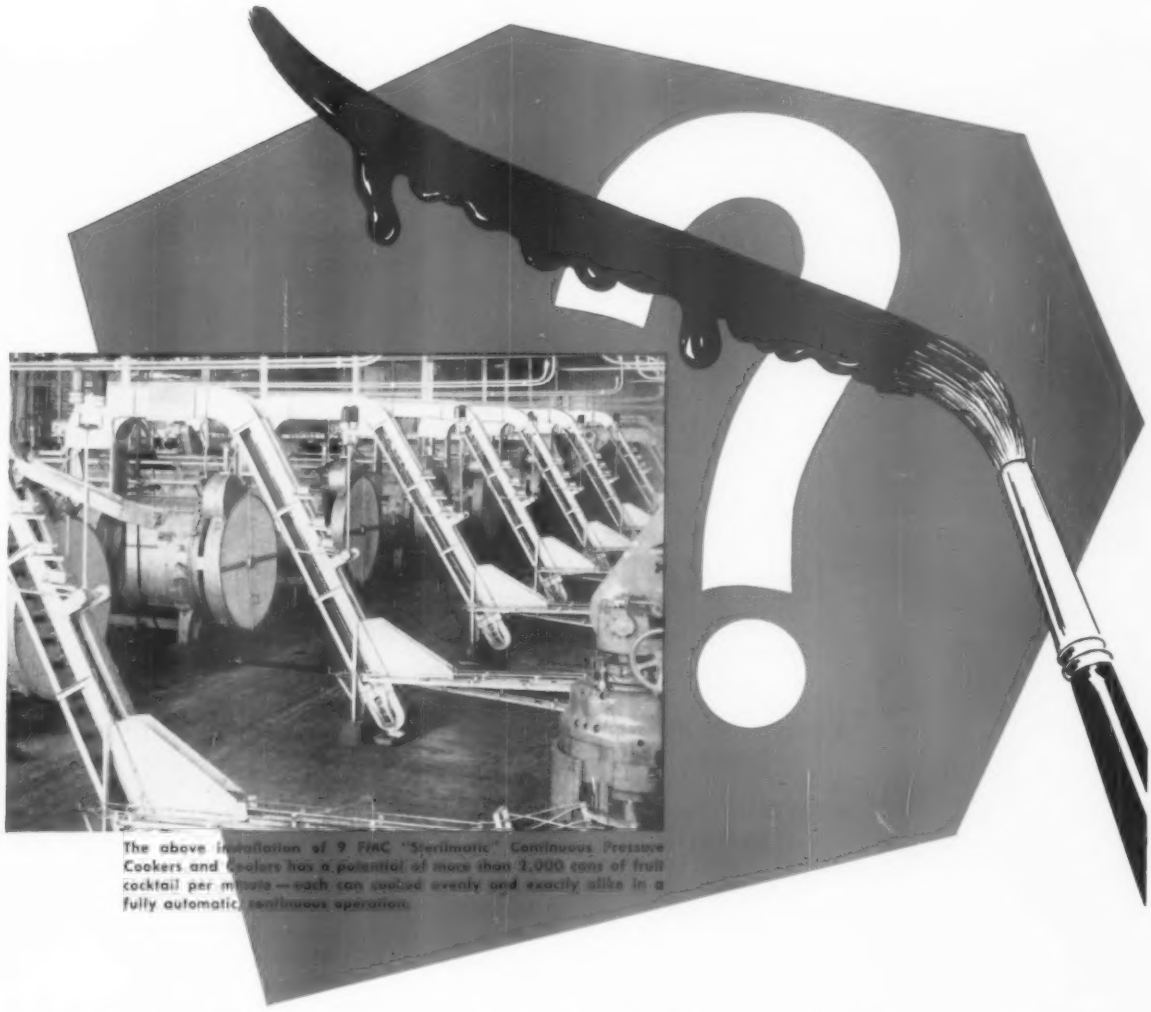
(Continued from page 24 preceding technical papers)

Name	*Degree*	*Title of Thesis*
Gardner, Donald S.	S.M.	The Effects of Food Ash on the Development of Caries in Hamsters
Hultin, Herbert O.	S.M.	Nitrogen Compounds in Instant Coffee
O'Neil, John J.	S.M.	Studies on Submerged Culture Production of Mushroom Mycelium
Tereshkevitch, Wlodzimievz	Sc.D.	Oxygen Absorption from Gas Bubbles Under Shear Between a Rotating Drum and a Stationary Cylinder
UNIVERSITY OF MASSACHUSETTS AT AMHERST		
Arenas, E.	M.S.	A Comparison of Food Regulations of Chile and The United States
Brody, H. D.	Ph.D.	Post-Harvest Application of Antibiotics and Growth Inhibitors on the Shelf-Life of Spinach and Asparagus
Chan, M. S.	M.S.	Metabolic and Toxicological Studies on Ethylenediamimetetracetic Acid in the Albino Rat
Feliciotti, E.	Ph.D.	The Thermal Destruction of Thiamine in Buffer Solution and Low-Acid Foods in the Temperature Range 228° to 300° F.
Gersten, B.	M.S.	A Colorimetric Procedure for Determination of Phosphorus in Foods
Irvin, K.	M.S.	Freezing Preservation of Quahog Clams
Khallouf, N.	M.S.	Some Public Health Aspects of Lebanon
Read, R. B.	Ph.D.	High Temperature-Short Time Pasteurization of Milk
Rotman, A.	M.S.	Color Stability in Bottled and Canned Carbonated Beverages
Steinberg, M.	Ph.D.	Chemical Aspects of Pectin — Gel Darkening
Tsuji, K.	M.S.	The Determination of the Freshness of Shrimp
Zapsalis, C.	M.S.	Storage Life of Pre-Peeled Potatoes (French Fry Style) Packaged in Plastic Films
UNIVERSITY OF MISSOURI AT COLUMBIA		
Finley, Neil	M.S.	Influence of Plastic Vat Covers on the Fermentation of Cucumbers
Johnston, Melvin R.	Ph.D.	Lindane Residues in the Fermentation and Processing of Pickles
NORTH CAROLINA STATE COLLEGE AT RALEIGH		
Calhoun, Fred H., Jr.	M.S.	Standard Cycle Times Applied to Milk Bottle Case Handling in Dairy Plants
Gregory, Max Edwin	M.S.	Labor Utilization and Employee Efficiency in Seven North Carolina Milk Plants
McAnelly, John K.	M.S.	Studies on a Peptide Stimulatory for the Growth of Certain Bacteria
RUTGERS UNIVERSITY AT NEW BRUNSWICK, NEW JERSEY		
Wodicka, Virgil O.	Ph.D.	The Nature and Properties of the Pigment of Cured Meats
OREGON STATE COLLEGE AT CORVALLIS		
Dunning, Robert L.	M.S.	Chromatographic Analysis and Biosynthesis of Peppermint Oil Terpenes
Fortner, Leland U.	M.S.	Labor Requirements of Different Methods of Using Polyethylene in Pear Packing Operations

(Continued on page 42)



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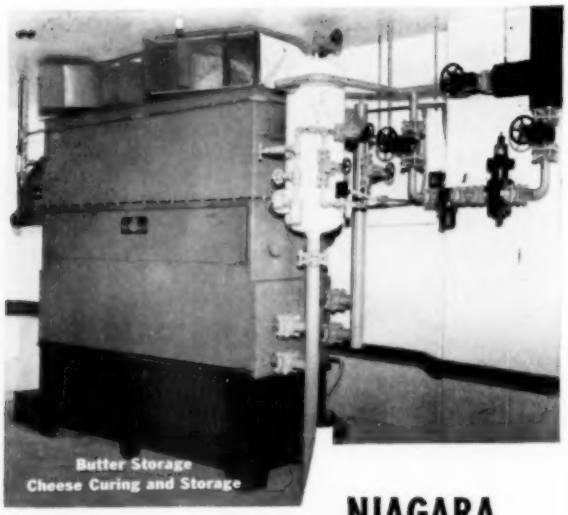

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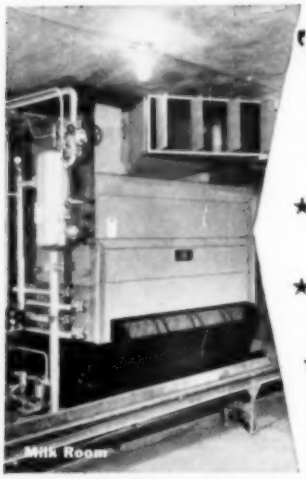

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(Continued from page 40)

Name	*Degree*	*Title of Thesis*
Hudson, Leland W.	M.S.	The Inheritance of Resistance to Fruit Cracking in the Tomato (*Lycopersicon esculentum* L.)
McDaniel, Fred B.	M.S.	The Influence of Acidity Control During the Manufacturing Process on the Market Quality of Cottage Cheese
Narula, Prem N.	Ph.D.	The Distribution of Nitrogen Compounds in Goat's Milk
Parker, Richard B.	Ph.D.	Nutritional Factors in Milk Affecting Growth of Lactic Acid Streptococci and Lactobacilli
Pettit, Lynne A.	Ph.D.	The Effect of Certain Psychological and Environmental Factors on Flavor Preference Testing
Rahman, Abdul R.	Ph.D.	Histological and Histochemical Investigations of the Effect of Certain Chemicals Upon the Quality of Dehydrated Peas
Renney, Arthur J.	Ph.D.	Some Effects of CMU (3-parachlorophenyl 1,1-dimethylurea) as a Pre-Emergence Herbicide on Peppermint, Potato and Grain Crops
Schnautz, John A.	M.S.	Effectiveness of Certain Spices in Protecting Beef from Gaining Flavors from Gamma Radiation
Suri, Balwant R.	Ph.D.	Chemical and Physical Changes in Isolated Beef Muscle Tenderized by Infusion with Sodium Chloride
Teeny, Fuad M.	M.S.	Potato Sugar as a Sweetener for Some Food Products
Twigg, Kenneth W.	M.S.	Sherbet Studies Using Orange and Cranberry Concentrate
Valassi, Kyriake V.	Ph.D.	The Effect of Mixing Speed on the Physical Properties of Cake Batters With and Without Fat Emulsifier
Watkins, Sprague H.	M.S.	Destruction of Lactic Acid Streptococcus Bacteriophage by Various Bactericidal Agents
Wiedman, Harold W.	Ph.D.	Factors Influencing Development and Control of Root Rot of Bean, *Phaseolus vulgaris* L., in the Willamette Valley of Oregon
Williams, Harold E.	Ph.D.	Cross Protection in Stone Fruits with the Ring Spot Virus Complex

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Laskin, Allen I.	Ph.D.	Oxidation-Reduction Potentials in Cultures of *Clostridium botulinum*

STATE COLLEGE OF WASHINGTON AT PULLMAN

Litman, Irving I.	Ph.D.	Study of the Fat-Protein Complex in Powdered Whole Milk
Nagmoush, Mounir R.	Ph.D.	The Nitrogen Source and the Oxidation-Reduction Potential as They Apply to Mold Growth
O'Brien, Robert T.	Ph.D.	Proteolytic Enzymes of Thermophilic Bacteria

UNIVERSITY OF WISCONSIN AT MADISON

Birdsall, John J.	Ph.D.	Effect of Chlorinated Hydrocarbon Insecticides on the Flavor of Various Vegetables
Gold, Harvey J.	M.S.	A Study of Horticultural Factors Affecting Quality of Canned, Machine Harvested Green Snap Beans
Monnberg, Birgit M.	Ph.D.	Effect of Chlorinated Hydrocarbon Insecticides on Sugar Components of Beets and Rutabagas

BUT SO SIGNIFICANT!

A needle . . . a tiny, unobtrusive needle, yet it has to do big jobs, jobs it alone can do. But a wrong needle, or an imperfect needle can just mean wasted effort and wasted money.

And so it goes in food processing. Many processors use top grade ingredients and the latest techniques. Yet, when it comes to spices – the small but significant ingredients that give the product its taste, its sales appeal – many do their skill an injustice. After all this care, they cut corners when it comes to spices.

Knickerbocker spices . . . cinnamon, mace, nutmeg, paprika, ginger . . . are selected *for* manufacturers. They make the difference between a product that is just "O.K." – and one which will bring increased sales. From its raw state to its final form, each variety is kept uniform in quality . . . consistent in strength and flavor. And because Knickerbocker spices are *real* spices . . . there's less loss of flavor . . . you'll find they are stronger . . . more aromatic . . . *you'll use less!*

Not only will your customers *taste* the difference – your cash register will *show* the difference. Price lists and detailed information are available on request.

KNICKERBOCKER

SPICES

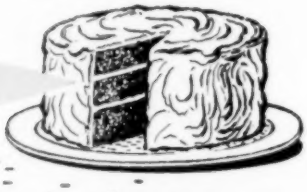
Since 1842 America's Leading Importers of Fine Spices

KNICKERBOCKER MILLS CO.

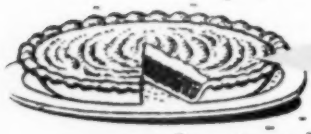
601-621 West 26th Street New York 1, New York

FINE FLAVOR

CAKES



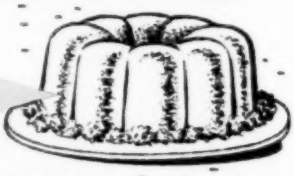
FORMULATIONS



PIE FILLINGS

FOR THE FOOD

GELATINS



INDUSTRY.....

PUDDINGS

FRIES & FRIES

flavors

Developing new and distinctive flavors or supplying established ones are equally important at Fries and Fries.

Our modern flavor laboratories are staffed with highly skilled chemists and technicians who have helped perfect the flavorings of many fine products found on every supermarket shelf.

Your inquiry will be given prompt attention and treated in strict confidence.

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FOOD INDUSTRY TOPICS...

. . . by Norb Leinen

. . . in the public interest

If the Midwest is going to progress with the rest of the nation, its future lies in science-based industries, Dr. Chas. N. Kimball, president of Midwest Research Institute, 425 Volker Blvd., Kansas City, Mo., stated in his annual report to the Institute's Board of Trustees. "For every two jobs created in industry and services over the past 15 years, our region lost one in agriculture," Dr. Kimball declared. "We can compensate for the decline in farm jobs by greater industrialization, not only in the cities, but also in the small rural trading centers. Smaller communities are essential to our economy, and we cannot afford agricultural ghost towns like the abandoned Rocky Mountain mining communities," Dr. Kimball continued. "The present transitional era will require major readjustments of psychological outlook and habit on the part of all. But it holds out some wonderful prospects for the people, communities, and companies flexible enough to stimulate their thinking to meet the needs of the present technological age."

◆ ◆ ◆

Restoration of fresh natural flavor to foods after processing has been accomplished in a novel and important advance in the food field. The new technique was announced by scientists of the U. S. Army Quartermaster Research and Development Command, Natick, Mass., and Evans Research and Development Corp., 250 E. 43rd St., New York City. The research team, which revealed that enzymes could be used to release latent flavor locked up in many processed foods in the form of flavor precursors, consisted of (from left): Dr. K. S. Konigsbacher, Evans Research; Dr. Donald A. M. Mackay, Evans Research; Dr. Tortsen Hasselstrom (seated), QM Research and Development Command; and Dr. Eric J. Hewitt, Evans Research. They have been engaged in a program of research in which one of the objectives was to make dehydrated cabbage more palatable for use in feeding Armed Forces personnel. In their report, they described experiments in which the natural fresh flavor of raw cabbage was restored to dehydrated cabbage by treating it with water and an enzyme preparation made from mustard seeds. The general applicability of the process has been shown by making flavor improvements in such diverse processed foods as peas, celery, leek, spinach, pineapples, onions, tomatoes, oranges, bananas, parsley, strawberries, milk, and carrots. The scientists emphasized the necessity for finding suitable sources rich in the enzymes necessary for each particular food. They also pointed out that the processing of the food must not be so severe as to destroy the flavor precursors that are essential to the working of the process.

◆ ◆ ◆

Celanese Corporation of America, 180 Madison Ave., New York 16, N. Y., announced it has established graduate fellowships in 13 universities in its continuing program to assist and encourage develop-

(Continued on page 46)

CONTINENTAL *Landmarks*

Periodic progress reports of interest and value to the food processing field

Self-tracking Gripstrip® simplifies key-opening of coffee, shortening and meat cans

The annoying problem of "off-key" rip strips on key-opening cans has now been eliminated with Continental's self-tracking Gripstrip. Developed by Continental engineers, Gripstrip consists of a multiple bead between the scored lines of the rip strip. Thus, each turn of the key locks this beaded strip into a slip-proof coil . . . all the way around the can.

Already in wide commercial use on Continental coffee and shortening cans, Gripstrip is now also available on our 12-oz. luncheon meat cans, large oblong meat cans and pear shape ham cans.

In addition to offering the consumer extra convenience, Gripstrip actually strengthens the can body. Yet Gripstrip cans cost packers no more than ordinary containers.

Like so many other Continental advances, Gripstrip demonstrates our continual interest in every detail of packaging quality — backed by nationwide facilities for research and development.

TAILOR-MADE PACKAGE SERVICE

CONTINENTAL CAN COMPANY

Eastern Division: 100 E. 42nd St., New York 17
Central Division: 135 So. La Salle St., Chicago 3
Pacific Division: Russ Building, San Francisco 4

Today's Biggest Value

IN BACTERICIDES

KLENZADE X-4
SODIUM HYPOCHLORITE SOLUTION

- New and improved — nearly 40% more bactericidal power at no increase in price.
- Sodium Hypochlorite content increased from 4.62% to 6.4%.
- Saves money — goes one-third again as far.
- Lower pH, kinder to hands — use dilutions are non-injurious to equipment.
- Leaves no film, sediment, or deposits — rinses clear and free — easily diluted — always ready for use.
- One of America's most popular and widely used safe bactericides for dairy farms and plants.

KLENZADE PRODUCTS, INC.
Branch Offices and Warehouses Throughout America
BELOIT WISCONSIN

KLENZADE FOG SANITIZER

(Continued from page 44)

ment of deserving graduate students for scientific careers. Fields of study covered include physics, chemistry, engineering, textiles, cellulose, and plastics. Participating institutions are: Cornell University, Georgia Institute of Technology, University of Illinois, Louisiana State University, Lowell Technological Institute, McGill University, North Carolina State College, University of Oklahoma, Princeton University, Rice Institute, University of Texas, University of Maryland, and Yale University.

◆ ◆ ◆

Truesdail Laboratories, Inc., Los Angeles and Honolulu, announce the creation of a new $1000 annual scholarship to be known as the Truesdail Chemistry Scholarship. The award, established at the University of Redlands, will make it possible for an outstanding sophomore student in chemistry to continue study for his junior year. The recipient also will receive opportunity for summer employment at the Truesdail Laboratories in Los Angeles.

◆ ◆ ◆

An entirely new concept of merchandising macaroni products was announced at the recent 52nd annual convention of the National Macaroni Manufacturers Assn. A national publicity, merchandising, and advertising program scheduled to break this Fall during National Macaroni Week, October 18-27, will feature a low-calorie macaroni dinner aimed at the estimated 40 million Americans dieting every year. The dinner totals approximately 550 calories per serving—well below the calorie count of the average dinner. One menu features spaghetti with a rich meat sauce, tossed salad with vinegar and oil dressing, canned cling peach halve, and black coffee or tea.

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Industrial research directors were warned by one of their top colleagues to balance their programs with both long- and short-term projects to avoid "trying the patience" of management. "To the researcher himself," said Dr. Roger H. Lueck, vice president in charge of research of American Can Co., "a negative result is often as valuable as a positive one. Unfortunately, however, it is very difficult to translate negative results into company profits that favorably influence a board of directors." He added that "the research director does well to incorporate in his program a percentage of short-term projects where the chances of success are better than average. This is desirable even where the objectives of such projects are of less potential value to the company than those of projects requiring a matter of years to bring to a conclusion." Dr. Lueck said it "should not prove difficult" for research directors to develop a number of profitable short-term projects which would provide needed technology as well as help support long-term research.

◆ ◆ ◆

The emphasis upon group effort in modern industry presents the serious problem of how to preserve the creative genius of the "uncommon man," Mr. Crawford H. Greenewalt, president of the Du Pont Company, told the American Newspaper Publishers Association recently. Recalling achievements of the last

(Continued on page 48)

D&O CONDIMENT SEASONING CHART

For manufacturers supplying the vast "condiment" market, D&O has developed several specific lines of seasoning products. Each group possesses distinct qualities required by certain types of condiment products, making for an extensive and versatile coverage of the field. The chart below presents, briefly, these basic properties. For more complete information, order copies of the brochures prepared especially for this purpose.

PRODUCT	D&O SEASONING RECOMMENDED	PROPERTIES
PICKLES AND RELISHES	SPICEOLATE SPISORESIN SPISORAMA	*Spiceolate Seasonings* Water-soluble, spice flavors made from pure natural oils and oleoresins. Completely pure.
SALAD DRESSINGS	SPICEOLATE SPISORAMA SPECIALTY #M1002	*Spisoresin Seasonings* Oil-soluble seasonings made from special extractions of natural spices. Completely pure.
SAUCES AND CATSUP	SPICEOLATE SPISORAMA	*Spisorama Seasonings* Dry-soluble seasonings made from pure oils and oleoresins, prepared on a dry carrier for easy dispersability.

Available on request

- SPICEOLATE BROCHURE
- SPISORESIN-SPISORAMA BROCHURE
- SALAD DRESSING BROCHURE

Essentially for You

D&O ESTABLISHED 1798 ®

OUR 157th YEAR OF SERVICE

DODGE & OLCOTT, INC.

180 Varick Street, New York 14, N. Y.

Sales Offices in Principal Cities

ESSENTIAL OILS • AROMATIC CHEMICALS • PERFUME BASES • FLAVOR BASES • DRY SOLUBLE SEASONINGS

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flavors

BY P&S
make delicious
dietetic food

The calorie-conscious become taste-conscious through dietetic flavors by P & S.

There's more flavor (and greater sales potential) in P&S Dietetic flavors because there's more skill in their preparation . . . more testing . . . more knowledge.

Try samples without obligation in any flavors you desire. You'll be amazed at the quality a Dietetic flavor can achieve.

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INCORPORATED
667 WASHINGTON ST., NEW YORK 14, N. Y.
Offices: Chicago, Ill.; Cinn., Ohio; Los Angeles, Calif.; Toronto, Can.
Plants: Teterboro & Guttenberg, N. J.; Culver City, Calif.; New York, N. Y.

(Continued from page 46)

half-century—the transportation revolution, universal use of electricity, and unlocking the atom—Mr. Greenewalt declared "future developments may be expected in the next generation that will prove at least as startling as those in the past 50 years." He added: "Just when we will realize this problem of the future and how far the new developments will take us depends on how well we are able to recognize and encourage individual achievement." In all progress, he said, "the great problem is to develop within the framework of the group the creative genius of the individual. "It is a problem for management, for public education, for government, for the churches, for the press—for everyone," he declared. "The stake is both the material one of preserving our most productive source of progress and the spiritual one of insuring to each individual the human dignity which is his birthright. Unless we can guarantee the encouragement and fruitfulness of the uncommon man, the future will lose for all men its virtue, its brightness, and its promise."

. . . *things new under the sun*

New transparent Freezer Queen bags made of Tenite polyethylene keep refrigerated foods moist and fresh, save work and time in packaging meats, vegetables, or fruits for home freezing. The tough, odorless plastic serves as a moisture barrier, and at the same time permits a clear view of the items it encloses. The bags remain soft and pliable at sub-zero temperatures. After use, they can be rinsed clean in warm water and are ready for further service. The freezer bags are marketed in two different packages—one containing five bags of a 2-qt. or 4-lb. size, the other a kitchen assortment including seven bags ranging from the large 2-qt. size down to a 1-pt. or 1-lb. size. In addition to refrigerator or freezer use, the bags are handy for packing lunches, covering silver, or storing small dry goods items in the household. For details, write Freezer Queen Products Co., 210 S. Clinton St., Chicago 6, Ill.

◆ ◆ ◆

A specially purified catalase called Armalase-A100 (liquid) has become a regular sales item of the Armour Laboratories and will be marketed through the newly-formed Bio-Chemical Department. The product, extracted from animal liver, was previously distributed as a market development item by the firm's Research Division. Armalase-A100 rapidly converts dilute solutions of hydrogen peroxide into water and oxygen. It has been used successfully in the food, brewing, soap, textile, fur, rubber, leather, and cosmetic industries. It may also be used to advantage in combination with hydrogen peroxide in the manu-

(Continued on page 50)

Got a Processing Problem?

Think your processing could be better? More economical? Ask the men at Quaker Oats—they can find the answer!

What Quaker has done in the food processing field is a truly *amazing* story. A story that *should* be told in person.

Quaker, with years of experience in oats, corn and barley, recently added rice flour to the list. These flours have almost *unlimited* application in food processing. They are extremely neutral. Used as thickeners or carriers they assume characteristics of other ingredients—or characteristics can be accentuated or eliminated. You can have *any* size granulation—from the original grain to microscopic size. And all work is done under excellent temperature control. Yet these flours are very economical—save you money in processing.

Quaker's men and modern machines will work on *any* type of blended product. They insure you of highest quality. Quaker offers diversification of mills so all your eggs aren't in one basket. And Quaker is equipped to handle bulk—still another saving for you.

Quaker's resources and abilities in the processing field have only been touched upon here. The possibilities are endless. Let us help you as we have already helped so many major food companies. If you have *any* processing problem, call or write Industrial Food Sales, The Quaker Oats Company. No matter *what* the problem, it will be worth your while.

QUAKER

THE QUAKER OATS COMPANY
CHICAGO 54, ILLINOIS

(Continued from page 48)

facture of cheese by destroying, selectively, certain harmful bacteria in milk without harming beneficial enzymes. This use requires approval of the federal Food and Drug Administration, which now is pending.

◆ ◆ ◆

Legendary bear serves as theme of this poster of Japan Gasoline Co., sales agent in Japan for Universal Oil Products Co., Des Plaines, Ill., for Sústane (R), UOP's additive that protects food from rancidity. According to a legend of the Ainu, North Japan aborigines, the bear was quite a fisherman, and impaled his catch on a bamboo pole. But he wasn't bright enough to plug the end of the pole, and the fish slipped off as he walked home. The Ainu, smarter than bears, followed him and picked up the fish enroute, saving themselves the trouble of looking for food. Freely translated, the copy says, "Don't be like the bear—use Sústane to protect your food."

◆ ◆ ◆

Sorbistat, a compound which successfully inhibits mold and yeast growth in a wide range of food products, has been made available to processors by Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y. The compound, Pfizer's brand of sorbic acid, has been tested extensively and found to inhibit selectively the growth of many molds and yeasts, as well as of certain bacteria which cause spoilage, according to Mr. Paul E. Wever, sales manager of Pfizer's Chemical Sales Division. Its anti-mycotic—or anti-mold—action has been evaluated in such foods as cheese and cheese products, pickles, fish, soft drinks, prepared gelatin fruit salads, potato salads, chocolate syrup, and cakes. As a result of comprehensive pharmacological tests, the Food and Drug Administration has found it safe for incorporation in films and other food packaging materials. A one-half pound sample of Sorbistat and technical information are available from Pfizer's Chemical Sales Division.

◆ ◆ ◆

A new oil bath air filter which combines high efficiency with extremely low pressure loss has been announced by Air-Maze Corp., 25000 Miles Rd., Cleveland 28, O. The new LPD achieves low-pressure-drop operation without any moving parts or any outside energy supply. The result makes economical oil bath filtration available for use with a much broader range of compressors, blowers, and engines. The smallest of the four models, recommended for variable speed engines and compressors, has a capacity range from 800 CFM to 3500 CFM, with a pressure drop of 0.6"

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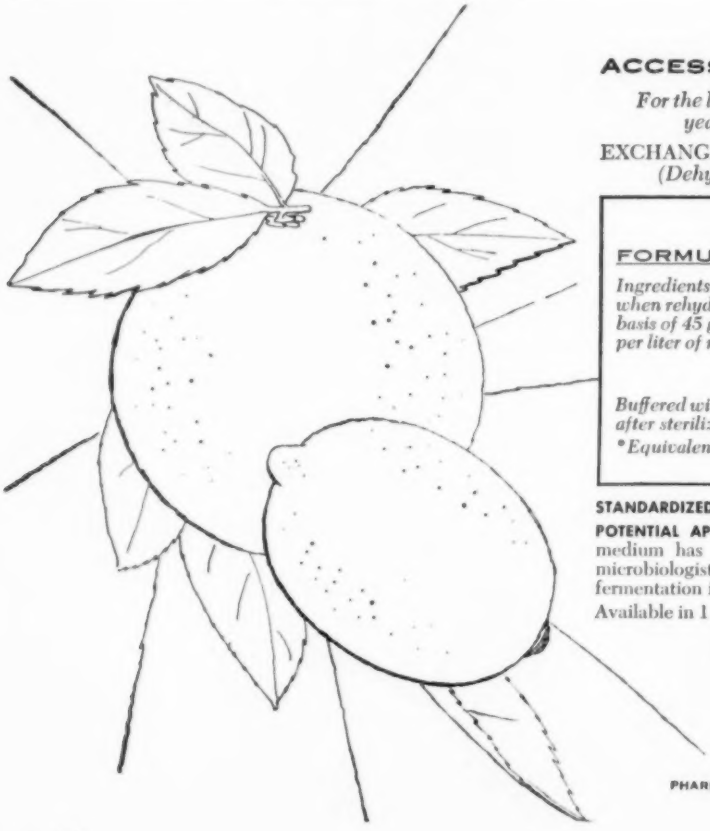


ACCESSORY NUTRIENT FACTORS

For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77
(Dehydrated) a Complete Culture Medium

FORMULA		
Ingredients— when rehydrated on basis of 45 grams per liter of medium.	Orange juice serum solids	12.6g*
	Agar (dry basis)	15g
	Peptone	10g
	Yeast hydrolysate	3g
	Reducing sugars, total	8g
	Sucrose, total	6g
	Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.
**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit, pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

Sunkist Growers
PRODUCTS DEPARTMENT

Exchange ®

PHARMACEUTICAL SALES · ONTARIO, CALIFORNIA

In many plants, Celite diatomite filtration has helped process control men maintain the desired balance between clarity and flow rate.

CELITE FILTRATION assures perfect clarity at fastest flow rates

For maximum clarity, Celite* offers a filter cake hundreds of times finer than the finest wire mesh. *For maximum flow rate,* Celite offers more than 2,500,000 filter channels in every square inch of the filter cake's surface. Thus, you can maintain highest quality without handicapping your production schedule . . . expand production without creating a clarification bottleneck.

Celite is diatomite . . . works with almost automatic ease with any standard pressure filter. To meet your specific requirements, Celite comes in nine standard grades of microscopically controlled particle size.

Celite is in wide use today filtering sugar, beer, jellies, syrups, cooking fats and oils. If your product is in a liquid state at some stage of processing, perhaps Celite can help you solve the quality versus production problem. A Celite engineer can give you the answer fast.

To get in touch with a Celite engineer or obtain further information on Celite diatomite filtration, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products.

JM PRODUCTS

Johns-Manville CELITE FILTER AIDS

SANITATION
starts with
IN-PLANT CHLORINATION

From start to finish of your processing operation, *Wallace & Tiernan In-Plant Chlorination* will keep your sanitation problems to a minimum by:

Eliminating slime formation on equipment and in work areas

Retarding bacteria growth

Greatly reducing offensive odors

For information on how In-Plant Chlorination can help solve *your* sanitation problems, write today to our Foods Division.

WALLACE & TIERNAN
INCORPORATED
25 MAIN STREET BELLEVILLE 9, N. J.

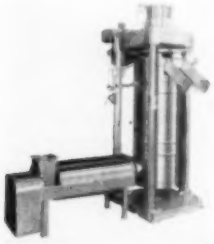
I-46

(Continued from page 50)

water gauge at the minimum, and 4.8″ at the maximum. The largest model, for constant speed engines and compressors, ranges in capacity from 16,500 CFM to 24,000 CFM, with a pressure drop ranging from 1.9″ to 3.5″. A bulletin describing the LPD oil bath filter is available.

◆ ◆ ◆

Commercial production of a Vertical Screw Press has been announced by the Canning Machinery Division of Food Machinery and Chemical Corp., P. O. Box 1120, San Jose, Calif., and 103 E. Maple St., Hoopeston, Ill. The FMC Press is designed to extract fluid from a given product for the purpose of further processing of the recovered fluid, or the remaining pomace that has been pressed, or perhaps both—depending upon the particular application and product. Employing the FMC "Flo-Mor" backing screen, the press will provide up to 30% more draining area per square foot of screen surface, which results in greater machine capacity. The Press has potential application in virtually any industry that requires a pressing application for the extraction or separation of fluid from a product.



FMC's Canning Machinery Division also announces it has become the exclusive distributor of the Allen Vibrating Table, a unique machine designed for inspection, sorting, and conveying operations.

◆ ◆ ◆

A device designed to prevent vaporization and splashing of liquids under agitation in a Waring Blendor is announced by Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill. The Cenco-Pinto Surface Cooler operates on the principal of stabilizing the agitated liquid at its surface, where cooling is most effective, maintaining the contents of the container at 1° or 2° C. above the temperature of the circulating water. The Cooler consists of a hollow copper bulb 3″ in diameter, with a tubular neck. The top of the neck contains water inlet and outlet tubes soldered in a metal cap. The metal sphere, or bulb, is the immersion end of the cooler. The device, with an over-all height of 13″, may be clamped on a ring stand and lowered into the Blendor as required. It will fit any standard Blendor container of about 1000 ml. capacity. Price, without support, is $19.95.

◆ ◆ ◆

Aluminum poultry boxes, like the one pictured here, have resulted in a savings of more than $20,000 annually for J. Weingarten, Inc., a Houston, Texas, chain store operation, since they were put into use at the firm's poultry processing plant. The boxes are manufactured by the material handling division of Mid-West Metallic Products, Inc., 2108 Payne Ave., Cleveland, O. Each box holds 25 dressed chickens, averaging 2¼ pounds each, and packed in chipped ice. The boxes measure 12″ by 12″ by 24″. Perforations on the bottom provide drainage for melting ice. The boxes are easily washed and sterilized after each shipment and used over and over again.

◆ ◆ ◆

A compact, motor-driven portable psychrometer for determining relative humidity has been developed by Friez Instrument Division of Bendix Aviation Corp. The self-contained precision instrument, named the Psychron, was designed to rigid government specifications for use by the U. S. Weather Bureau. The commercial model also will be useful in many other fields where temperature and humidity must be closely checked or controlled—including food processing and preservation. Its advantages over the widely used sling-type psychrometer include easier and safer close-quarter operation and more precise aspiration rate. It also is immune from radiation effects of the sun.

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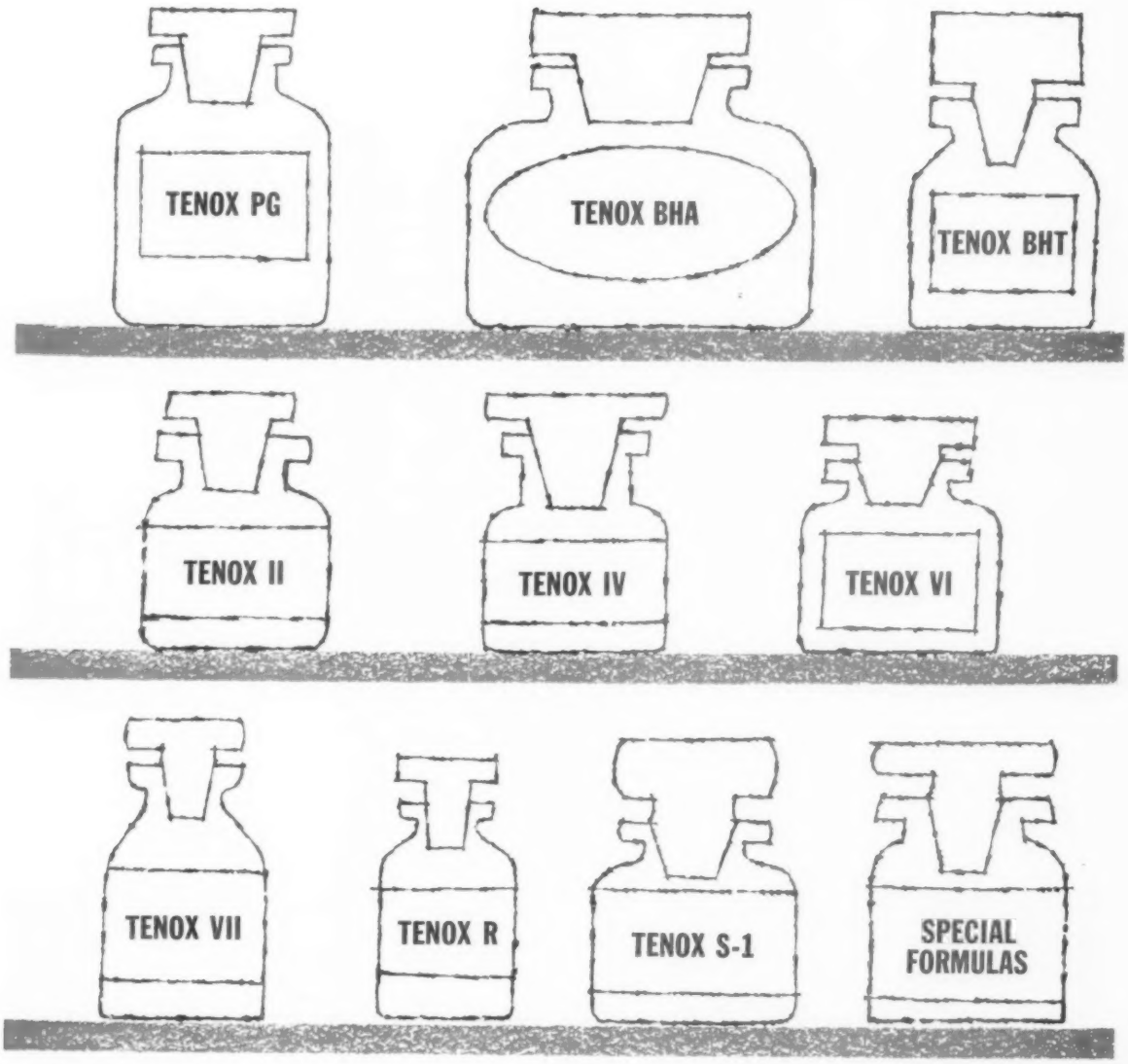

When you need an antioxidant...

Which antioxidant to use? How much to use? How to use it?

These are questions Eastman is well-qualified to answer.

For Eastman is the leader in food-grade antioxidants. The leader in volume, in experience, in accumulated data. No other manufacturer produces so many basic antioxidants. Hence, no other supplier can match Eastman's dependable counsel on their proper and economical use.

Take advantage of this leadership. Call in Eastman food specialists for complete and interested technical assistance in the use of Tenox antioxidants to protect your sensitive food products against development of rancidity, and off-flavor.

Write to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Tenox
Eastman food-grade antioxidants

(Continued from page 52)

and has a built-in thermometer illumination system for easy reading in the dark. The unit weighs 2½ pounds, is 10″ long, $4\frac{5}{16}$″ high, and $1\frac{13}{16}$″ wide. It operates in a relative humidity range of from 10 to 100%, and a temperature range of from 10° to 100° F. Company officials estimate the complete commercial unit will be available this fall and will sell at about $80. Write the company c/o Carl Byoir & Associates, Inc., 10 E. 40th St., New York 16, N. Y.

◆ ◆ ◆

Cold water and steam can be mixed automatically to provide hot water at any desired temperature by a **unique mixing control** described by the Powers Regulator Co., 3434 Oakton St., Skokie, Ill. Called the Style D Mixer, the control can be used to obtain hot water where only cold water and steam are available, or to superheat plant hot water for a processing operation. The mixer takes steam and cold water at pressures from 10 to 100 pounds. Check valves built into each inlet prevent interchange of steam and cold water when the mixer is not in use. The temperature adjustment handle also operates an internal delivery shut-off valve. The unit is available in ½″ and ¾″ sizes. List price is $65 for the ½″ mixer, and $130 for the ¾″ unit. Write for Bulletin 369.

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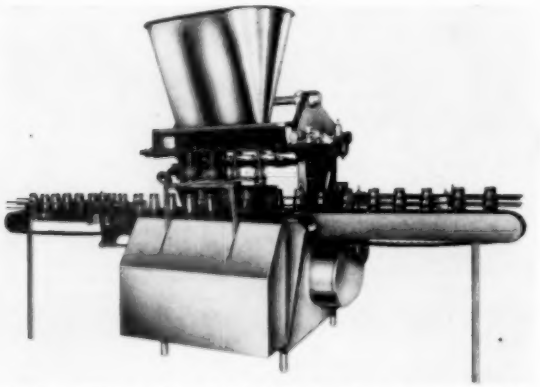

A piston filling machine that handles from 2-oz. to quart and 2-lb. containers, and fills semi-liquids and semi-solids including food, dairy, and chemical products is offered by Filler Machine Co., Inc., 10 Penn Ave., Rockledge, Philadelphia 11, Pa. The unit, called the Model SL55, is a straight line filler and will not fill unless containers are under the filling nozzle. Valves are completely air-free, and pallets are air-operated, insuring accurate filling of the many different sizes and types of containers the machine handles. Type of fill is by the bottom-up method to eliminate air pockets and insure a completely solid pack. Speed of fill is from 60 to 88 containers per minute, with higher speeds available. All parts are slow-moving to decrease wear and maintenance.

◆ ◆ ◆

A new can delivery system that with only one man on the loading platform put an average of 1,200 ready-to-fill 6-oz. cans per minute directly into a cannery filling line was demonstrated by Crown Cork & Seal Co., Inc., at Minute Maid Corporation's citrus concentrate plant, Leesburg, Fla. The Crown can delivery system utilizes a conventional flat bed highway trailer which transports eight specially built can containers discharging by gravity, and a wheeled boot device mounted on a track set in a raised concrete platform. The boot enables the load of cans to be transferred in orderly ready-to-fill fashion from container to cannery filling line via a cableway extension. A Crown spokesman said that the entire subject of can delivery was undergoing intensive study by a top management committee. Additional improvements in the present Crown system that are already in advanced stages of development will not be made public until this committee has made its report. The firm may be addressed through J. M. Mathes, Inc., 260 Madison Ave., New York 16, N. Y.

◆ ◆ ◆

The shape of the Tote Bin makes it amenable to tiering. Storing hermetically sealed Bins saves at least 15-30% warehouse space—without tiering. With Bins placed one atop the other, just as pallets, even more space can be saved. Warehouses are cleaner and inventory control is simplified. For information on the Tote system for bulk material handling, write Mr. Carl Ackerman, Tote System, Inc., Beatrice, Nebr.

◆ ◆ ◆

An advance in **mechanized cleaning for the food and dairy industries** has been made in the development of the Oakite Fan Sprayer, Model 561. Manufactured by Oakite Products, Inc., 19 Rector St., New York City, the unit was developed to eliminate hand cleaning of storage tank interiors. The Fan Sprayer consists of a horizontal pipe fitted with two rows of solid jet nozzles set close together and at increasing angles. A small hydraulic motor imparts an oscillating motion up to 100°, and the entire unit is mounted on small rubber wheels so it may easily be moved along the floor of the tank. The combined forward and oscillating movements make it possible for the sprays to hit directly a large part of the tank interior, while the remaining surfaces are cleaned by the flow-down of the cleaning solution and rinse water. Under normal operating conditions and the recommended pressure of 60 p.s.i., the unit can clean surfaces about 12 feet away.

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Pennsalt Chemicals has announced formula improvements in their new type Raydex manual cleaner for dairies and food processing plants, now on the market. A granular type detergent, Raydex has been completely dedusted by a newly developed process greatly increasing ease of handling. In addition, a combination of non-ionic and anionic wetting agents

(Continued on page 56)

a flavor result never before possible* in CAKE MIX

* Because There's Never Been Anything Like It in Existence

VANILLA LABORATORIES Special Cake Mix Flavor, a product of our own laboratories, is something entirely new and different—yet already *proven* in actual *use.*

A complete flavor combining Pure Vanilla with other flavoring ingredients, so versatile that by slight changes in formula it can give any cake mix a distinctive flavor, it's tailor-made for you, yet budget priced.

We invite you to see for yourself the surprising flavor results that can be obtained by specialists working within a specialized firm.

SPECIAL PRODUCTS DIVISION
VANILLA LABORATORIES, Inc.
ROCHESTER, N.Y.

SPECIAL FLAVORS FOR PREPARED CAKE MIXES, PREPARED ICINGS AND PUDDINGS

SPECIAL PRODUCTS DIVISION
VANILLA LABORATORIES, Inc.
Rochester, N.Y.

Have your representative tell us about Vanilla Laboratories Special Cake Mix Flavors.

Ask for Mr._____

Firm Name_____

Address_____

(Continued from page 54)

has been added to the improved product to increase wetting and detergency action. Improved Raydex, one of Pennsalt's complete line of B-K sanitation chemicals, is available in 125- and 350-lb. full-opening type drums, at no increase in price. Write Pennsylvania Salt Mfg. Co., 3 Penn Center Plaza, Philadelphia 2, Pa.

◆ ◆ ◆

A stainless steel spiral slide is helping Armour and Company at their Herr's Island Plant (Pittsburgh, Pa.) to save money, time, elevator space, and give more uniform work loads. The slide, made of type 302 stainless steel supplied by Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa., is used for transporting bacon sides from the third floor cutting room to the first floor curing cellar at the plant. Little floor space was needed for the slide since it takes but a five foot square area. Rate of descent of the meat is controlled by the flow of a thin trickle of water which acts as a lubricant between the stainless steel and the meat.

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Three new models of apparatus for vapor-phase chromatography analysis are announced by Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill. Series 9400 Chromacon, with column and detector cell contained within a thermostatically controlled enclosure, continuously adjustable up to 150° C., with electronic strip chart recorder, 0-2 MV, one second pen speed, is regularly supplied with hot filament cell, but is available also with thermistor thermal conductivity cell. Series 9475 Chromacon is similar to the above, but has special internal arrangement, heavier insulation, special high-temperature heating system and detector cell, wiring and electric components, to operate up to 225° C. and higher as necessary to analyze components boiling from 150° C. to 300° C. Series 9485 Chromacon is a continuously automatic recording plant stream analyzer for rapid (2 to 10 min.) cyclic analysis of one to six or more gas or liquid streams. The firm also supplies custom-designed models to meet special requirements.

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Concentrated Soluble Oleoresin Turmeric No. 800 MM&R, ideal for seasoning and as a yellow vegetable color for food products, now is offered by Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y. It is stated to be stronger in color value, more completely soluble, and lower in price than other soluble oleoresins. Write for price information.

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A new liquid feed supplement that can significantly increase both weight gain in beef cattle and milk production in dairy cattle has been placed on the market by Feed Service Corp., Crete, Nebr. Trademarked MOREA, the development represents a new concept in ruminant feeding. Not only are the nutritional requirements of the animal taken into account, but special attention has been paid to satisfying the nutritional requirements of rumen microorganisms. By speeding up rumen digestive processes, cattle and sheep can eat more, assimilate more and, therefore, gain weight faster. National distribution is now being started, and the new liquid feed will be distributed in two forms: (1) as a complete supplement which will require only grain or low cost roughage, such as silage or range grass to satisfy nutritional requirements of cattle and sheep; and (2) as a concentrate which can be mixed with molasses to form the same compound.

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The Cyrovaporator, in addition to serving as a general freeze dryer, a dessicator, and a tray dryer, has a special infra-red attachment which radiates through a Pyrex drying chamber to produce far faster drying times. Three trays are provided inside the drying chamber which provide for 132 10-ml. serum bottles, or 45 50-ml. serum bottles, or 27 100-ml. serum bottles. By simply adding three additional shelves, this capacity can be doubled. Beakers, Petri dishes, centrifuge tubes, or any other container can be used, thus eliminating need of transfers before and after freeze-drying. The unit measures 22" by 15" by 66". Write E. Machlett & Son, 220 E. 23rd St., New York 10, N.Y.

◆ ◆ ◆

A new and superior **family of treated potato starches** which offer greater viscosity stability has been introduced by Morningstar, Nicol, Inc., 630 W. 51st St., New York City. Known as the Arogums, these products already are bringing quicker cooking, better luster, greater retention, more flexible coatings, and improved penetration to the paper and textile industries, and to other manufacturers concerned with sizing, coating, and finishing. The Arogums reportedly are superior to "chlorinated" starches made from cereal bases, with respect to: (1) larger granule size, (2) lessened set-back (reversion to the original gelation after the cook), and (3) narrower limits of viscosity variation. In relation to starches converted by enzyme action or acid treatment to reduce viscosity and ropiness, the Arogums have the valuable property of markedly less loss through conversion to sugar. The Arogums can be supplied to specification as regards maximum viscosity and the constancy or rise or fall of that viscosity with continued cooking and subsequent cooling. Five grades already are standard to meet present day requirements in those industries which desire higher solids contents in batches of workable fluidity. The product is shipped dry in 100-lb. multiwall bags.

(Continued on page 58)

Morton Salt Company's new million dollar laboratory at Woodstock, Illinois, is at the service of the Food Industry to help solve problems relating to salt.

"They don't taste the same as last time"

Too salty? Not salty enough? The Morton Salt method for testing salt content on potato chips helps control flavor.

Now chippers can check the consistency of their salting operation and maintain the ideal percentage of salt on chips that their customers prefer. It's easy to do with a Morton Salt Content Testing Procedure and Color Standard Stirring Rod.

The Morton procedure is fast and accurate. It is simple enough so that almost anyone can be taught to conduct it. And it makes it possible to turn out chips that are consistently appealing in taste and texture. Morton also helps with problems in flavor control with the right grade of salt for any operation.

How Morton can help you make a better product

Chances are Morton can help you turn out a better product for less money if you use salt for canning, packing or processing any food product. For Morton makes many grades of salt for the Food Industry, and only Morton has 9 strategically located plants to serve you. We offer fast delivery from a bag to a trainload at favorable prices and freight, *anywhere* in the country.

What's more, one of Morton's Food Technologists can assist you with on-the-spot help with any problem you have pertaining to salt. And he's backed by the services of chemists and salt scientists at Morton's ultra-modern research laboratory.

☐ Please send me your free Testing Procedure and Color Standard Stirring Rod for use in determining the salt content on potato chips.*

☐ I am not a chip packer but would like more information on how Morton can help me.

Name_____

Title_____

Company_____

Street_____

City_____ Zone_____ State_____

*Glassware and chemicals necessary may be obtained at a nominal fee from the Natl. Potato Chip Institute.

MORTON SALT COMPANY
INDUSTRIAL DIVISION
Dept. FT-8, 120 So. La Salle Street,
Chicago 3, Illinois

(Continued from page 56)

A solution to the problem of removing water from heat-sensitive, delicate materials such as pharmaceuticals, orange-juice, and beer reportedly is contained in Patent No. 2,735,779, assigned to The Commonwealth Engineering Company of Ohio. The problem is solved by removing the water in the form of ice crystals. These can be removed by various separation processes. This can be done without picking up in the ice the solid materials and the taste materials in the product that is being dehydrated. With the accomplishment of this objective, it is now possible to handle any type of heat-sensitive material. In the case of such materials as benzene, dehydration and removal of the water in the form of ice crystals is conducted at a temperature where the normal hazards of fire or explosion are completely eliminated. Write the firm c/o Wade Atkinson, 3952 Edwards Rd., Cincinnati 9, O.

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"Setsquick," an odorless, tasteless, high-melting-point pure vegetable product in pulverized form, is described as the **perfect hardener and weather conditioner for all types of candies and salted nuts** by the manufacturer, Henry H. Ottens Mfg. Co., 129-131 S. Front St., Philadelphia 6, Pa. The product prevents stickiness in hot and humid weather, seals out moisture and retains the high gloss of fine confections, is easy to use, and costs less than ½c per pound of candy or salted nuts. The firm also offers its latest "Bakers Catalog," containing prices for its full line of flavors, concentrates, extracts, powdered colors, emulsions, pastes, and icing base.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

August 6-10	Gordon Research Conferences, AAAS Conference on Food and Nutrition, Colby Junior College, New London, New Hampshire
August 13-15	International Apple Association, Atlanta, Georgia
August 17-25	Tenth International Congress of Entomology, McGill University and the University of Montreal, Montreal, Canada
September 5-7	International Ass'n of Milk and Food Sanitarians, Olympia Hotel, Seattle
September 10-17	The Perkin Centennial, Sponsored by the American Assoc. of Textile Chemists and Colorists, Commemorating the Discovery of Aniline Dyes, Waldorf-Astoria, New York
September 16-21	One hundred and thirtieth National Meeting of the American Chemical Society, Atlantic City, New Jersey
September 24-30	Third International Congress on Canned Foods, Rome—Parma
October 9-12	American Dietetic Association, Milwaukee
October 17-19	Nat'l Pickle Packers Association, Edgewater Beach Hotel, Chicago
November 12-15	American Bottlers of Carbonated Beverages, Public Auditorium, Cleveland
November 27-30	National Chemical Exposition, Public Auditorium, Cleveland
May 12-16, '57	**Institute of Food Technologists, Seventeenth Annual Meeting, Pittsburgh, Pa.**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

. . . *the literary corner*

The annual report of the Carver Foundation, Tuskegee Institute, Alabama, entitled "Ten Years of Progress Through Research," reviews the Foundation's activities since the present program of sponsored research and training of graduate students was inaugurated ten years ago.

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Reprints of three technical papers on the function of vitamin B_{12} in metabolism are available upon request to Dr. H. R. Kraybill, vice president, American Meat Institute Foundation, 939 E. 57th St., Chicago 37, Ill. Two papers describe the role of vitamin B_{12} in the synthesis of nucleic acids, vital chemical constituents of the cell nuclei. In the third paper, the importance of vitamin B_{12} in maintaining normal cell size of certain microorganisms is shown.

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"Phase Contrast Microscopy in the Examination of Starch Granules," by Helen B. Wigman, Wm. W. Leathen, and Martha J. Brackemeyer, reprinted from *Food Technology*, 1956, Vol. X, No. 4, is available free from Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa.

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The latest Dodge & Olcott, Inc., catalog of essential oils, aromatic chemicals, and certified colors, dated May 1956, contains 36 pages of price and product listings, definitions, and descriptions. Convenient and pocket size, the catalog is available upon request from D&O, 180 Varick St., New York 14, N. Y.

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SeaKem Technical Bulletin 42, explaining how to handle and use SeaKem Colloids, is available from Seaplant Chemical Corp., 63 David St., New Bedford, Mass.

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Kinney Mfg. Division, The New York Air Brake Co., 3529 Washington St., Boston 30, Mass., has prepared a 4-page, 2-color bulletin, No. 403, which provides a quick but comprehensive view of its line of small, air-cooled compound high-vacuum pumps. The pumps are offered in six models ranging in size from a ¼ hp unit, which has a displacement of 2.0 cu. ft. per minute, to a 3 hp unit having a displacement of 46 CFM. Each pump is designed to create absolute pressures below 0.2 microns (.0002 mm. Hg.), McLeod gauge. Readings of 0.1 micron are typical in blank-end tests.

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New 6-page Bulletin 301—The Askania Transometer—describes the applications for, and the features of, the instrument which comprises a positive displacement type flow meter and a pneumatic signal transmitter. Listed are the viscous and other liquids which the Transometer will handle. Write Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

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A new electric heating cable, manufactured under the trade name, Chromalox Silicone Thermwire, and

(Continued on page 60)

ATLAS Food Facts

FOOD INDUSTRY DEPARTMENT
CHEMICALS DIVISION

ATLAS POWDER COMPANY
WILMINGTON 99, DELAWARE

Atmos® 150 ice cream emulsifier scores highest of all "monos" on all 5 counts

New Atmos 150 mono- and diglyceride emulsifier will produce ice cream that is outstanding in the five important qualities of dryness, body, texture, whipping time, and overrun.

Other monoglyceride emulsifiers are uneven in their effect upon ice cream, as shown in the "scoreboard" at right. One emulsifier may give good overrun, but poor body. Another may impart good texture after freezing, but not the dryness desired to package or coat properly.

"Optimum balance" accounts for the outstanding performance of Atmos 150—perfect balance of mono- and diglycerides. The monos are important to produce dryness and stiffness. The diglycerides thoroughly disperse the monos in the mix . . . assure uniform performance under varying conditions of formulation and processing.

SCOREBOARD OF EMULSIFIER PERFORMANCE

Emulsifier	DRYNESS: Glass Reading at 90% overrun	DRYNESS: Visual Appearance	BODY: Standup, or stiffness from freezer	TEXTURE	WHIPPING TIME: to 90% overrun	OVERRUN
ATMOS 150	●	●	●	●	●	●
Ordinary Low Mono (A)	●	○	○	●	○	●
Ordinary Low Mono (B)	●	○	○	○	○	●
Special Low Mono	●	●	●	●	○	●
Distilled Mono	○	○	○	○	○	●
Distilled Mono diluted with oil	●	●	●	●	○	●
Combination Product	●	●	●	●	●	●
No Emulsifier	○	○	○	○	○	○

● Excellent ● Fair ○ Unacceptable

Sorbitol improves dietetic soft drinks

Atlas sorbitol is used principally as a conditioning agent to retain softness and improve texture, taste and keeping qualities of many types of food. In low calorie dietetic soft drinks, sorbitol is used for flavor dispersion and bodying purposes . . . improving "mouth feel" and adding new taste appeal. Only a small amount of sorbitol—1 to 1.5% of the finished beverage—can make a big difference in the consumer acceptance of the soft drink.

Atlas emulsifiers make shortening work better

Better taste, texture, and appearance can be achieved in many foods through the use of Atlas emulsifiers. For example, shortening containing Atlas emulsifiers produces consistently better cakes, toppings, icings . . . not 90% of the time but *all the time*. These are the only emulsifiers that have an optimum balance of monoglycerides (impart excellent cake baking and water absorption properties) and diglycerides (provide additional tolerance . . . assuring *consistently* superior performance under all baking conditions).

Call or write Atlas

for more facts on sorbitol, and food emulsifiers, and how they can be applied to advantage in your products.

(Continued from page 58)

utilizing the amazing heat resistant characteristics of silicone rubber to permit continued temperatures of 275° F., is described in Bulletin L-1138, available from Edwin L. Wiegand and Co., 7500 Thomas Blvd., Pittsburgh 8, Pa. The new development provides a convenient and accurate method of applying or maintaining heat in pipes, vats, or irregular objects where consistent high temperatures are required for controlling viscosity, chemical action, and volatility in fluids.

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France Actuelle, a Fortnightly Report for Americans on Modern France and the French Union, in the issue of May 15, presents as the lead story a report on France's contributions to nuclear science. On the lighter side, the journal recommends as a good buy for prospective visitors to France the 1956 edition of the world-famed Michelin Guide, published by the Michelin Tire Co., price $2.40. Included in the Guide are locations of all sights worth seeing, data on garages, street maps of cities, and ratings on restaurants and hotels in every city, town, and village of the country. U. S. editorial office of *France Actuelle* is 221 Southern Bldg., Washington 5, D. C.

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New Bulletin 1060 describes and illustrates the Series E. Chempump, a low-cost, compact canned motor pump that is less than eight inches long. Mounted directly in the pipeline, the unit is an axial flow design that gives heads to 20′ and capacities to 22 gpm. White Chempump Corp., Station N, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

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An 8-page brochure describing the new Barnes Differential Refractometer and discussing the theory and principles of refractometry has been published by Barnes Engineering Co., Stamford, Conn. Several applications of continuous refractive index measurements are given, as well as features and complete specifications of the three available models.

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The new Rogers Moisture-Controller, stated to be the first continuous, automatic moisture meter which measures, indicates, records, and controls moisture content of free-flowing solids, and the Coronatron ® Electrostatic Separator, which affords efficient dry separations at low operating costs (several models available) are the subjects of separate 4-page bulletins available from the Mechanical and Electronic Products Division, The Quaker Oats Co., 205 Water St., Akron, O.

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"Organic Acids in Brewed Coffee," third in a series of technical reports dealing with scientific research on coffee, has been released by The Coffee Brewing Institute, Inc., 551 Fifth Ave., New York 17, N. Y. The report reviews the results of a study by Ahmed F. Mabrouk and F. E. Deatherage at The Ohio State University, sponsored by the Institute.

◆ ◆ ◆

A two-line processed cheese filler that fills from ½ lb. to 5 lb. boxes and cartons, and can be changed over easily and quickly to fill different size containers is described in a new technical data sheet published by The Filler Machine Co., Inc., 10 Penn Ave., Rockledge, Philadelphia 11, Pa.

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Citrus fruits can be kept mold-free by exposure to gas on its way to market, according to University of California researchers, as reported in *Industrial Research Newsletter*, June 1956, published by Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill. The gas technique is reported cheaper and more effective than the present method of wrapping each piece of fruit in chemically treated tissue paper. The chemical is a mixture of salts producing ammonia gas when moistened.

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An over-all look at chemically refined and improved natural materials available to the food, confectionery, and other industries is available from Paisley Products, Inc., 630 W. 51st St., New York 19, N. Y. The 20-page brochure shows how wide is the range of starches and flours, dextrins, water-soluble gums, and polyvinyl acetate emulsions now available to the formulating chemist; it also gives a good perspective of the rapidly developing field of liquid adhesives for both packaging and manufacturing. Address requests to Mr. E. C. Lenz, vice president.

. . . *meeting hall and conference room*

The most advanced electronic theories and products of interest to the food processing industry will be presented at the 1956 Western Electronic Show and Convention in Los Angeles, August 21-24. The Show, which will be conducted at the Pan Pacific Auditorium, will feature the exhibits of 650 firms from all over the nation. A major part of them will be related to the advancement of the food processing industry—including the latest in automation, photo cells, automatic packaging, sterilization, counters, instrumentation, electronic gauges, and controls and material movement. The Convention, which will headquarter at the Ambassador Hotel, will consist of 48 conference sessions, during which some 190 technical papers offering valuable studies of the electronic industry's most advanced thinking will be presented. Information on the Show is available from Herbert Cerwin and Staff, 344 N. La Brea Ave., Los Angeles 36, Calif.

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The 11th National TAPPI Plastics-Paper Conference will be held on October 3-4, 1956, at the Institute of Paper Chemistry, Appleton, Wis. Mr. Jos. Pullman, American Cyanamid Co., chairman of the Plastics Committee, announces appointment of Mr. T. A. Howells, Institute of Paper Chemistry, as general chairman of the Conference. The 2-day program will consist of papers discussing new synthetic polymers and testing procedures for paper coating, saturation, and beater addition. Address Conway Hotel, Appleton, Wis., for accommodations.

◆ ◆ ◆

What the future holds for the bottled carbonated soft drink industry will probably be answered at the

(Continued on page 62)

"7,125 men and women signed up to join those already saving for their financial security..."

GEORGE H. COPPERS

President,
National Biscuit Company

"There is no greater honor than partnership in an enterprise as important to a nation as the Payroll Savings Plan for United States Savings Bonds. We view our recent person-to-person canvass of employees in behalf of Bonds as practical patriotism. It supports our Government's efforts to stabilize the value of the dollar. The campaign also benefited our employees. 7,125 men and women signed up to join those already saving for their financial security in this easy, automatic way."

The Payroll Savings Plan is the backbone of Series E Bond Sales. 8,500,000 employees in more than 45,000 companies invest more than $160,000,000 in Savings Bonds *every* month.

The person-to-person canvass is the keystone of The Payroll Savings Plan. In company after company person-to-person canvasses *conducted* by *employees* have increased participation to 60%, 70%—even 90% plus.

Why don't *you* conduct a person-to-person canvass in *your* company? Here are two, simple steps:

• Tell the Savings Bond Division, U.S. Treasury Department, Washington, D.C., you want to conduct a person-to-person canvass, they will show you how easy it is to install the plan.

• Over *your* signature tell your men and women you are 100% behind the Payroll Savings Plan because it enables them to build personal security . . . it is a check on inflation and helps to stabilize the dollar . . . it has set up a reservoir of reserve purchasing power—over $37.5 billion—the cash value of Savings Bonds held by individuals at the end of July, 1954. The greatest reserve of purchasing power this or any other country has ever had.

Your phone call, telegram or letter to Savings Bond Division, U.S. Treasury Department, Washington 25, D.C., will bring prompt co-operation from your State Savings Bond Director. Act today.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

THE INSTITUTE OF FOOD TECHNOLOGISTS

SeaKem "Colloids Out of the Sea"*
unique...
both in their reactivity with proteins and their ability to work well "in combination" with other colloidal materials
*Over 20 distinct types of SeaKem Stabilizers are available . . . each one a highly refined derivative of Irish Moss and standardized for a particular gelling, thickening, suspending or other function.
EXTRACTS
Ask to be put on our mailing list to receive SeaKem EXTRACTS — the exciting house organ that "tells all" about SeaKem "Colloids Out of the Sea"
Any special application problems? Write today!
Seaplant CHEMICAL CORPORATION
63 David Street, New Bedford, Mass.

(Continued from page 60)

forthcoming International Soft Drink Industry Exposition at the Cleveland Public Auditorium, November 12-15. More than 9000 soft drink bottlers, industry suppliers, and guests are expected. The American Bottlers of Carbonated Beverages, national association of the soft drink industry, is headquartered in Washington, D. C.

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The Third International Congress on Canned Foods will be held in Rome from September 24-28, 1956, and in Parma on September 29-30, where the congress attendees will visit the Eleventh Canned Food and Packaging Fair and attend a conference on machinery and equipment for the canning industries. The Congress, organized by the Comité International Permanent de la Conserve (International Permanent Committee on Canned Foods), 3 Rue de Logelback, Paris 17, France, is designed to promote the advance of scientific, technical, and practical knowledge useful to the canned food industry, and to develop the consumption of canned foods.

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Food additives will receive attention at the American Chemical Society Meeting next month. Food manufacturers are invited to send samples of their new products containing food additives to Convention Hall, c/o Mr. R. M. Warren, Atlantic City, N. J. The Ag and Food Chemistry Division and Chemical Marketing and Economics Division are featuring a display of new products utilizing food additives. Samples must be in Atlantic City by September 12.

. . . *building up and branching out*

General Plastics Corp., 165 Third Ave., Paterson, N. J., and American Durafilm Co., 2300 Washington St., Newton Lower Falls, Mass., have been appointed distributors for Du Pont's new "Armalon" tetrafluoroethylene single coated glass fabrics. Both firms are custom applicators of "Teflon" tetrafluoroethylene enamel, widely used in industry because of its anti-stick and anti-friction properties. It is expected that "Armalon" coated glass fabrics will solve problems relating to heat sealing bars on packaging machinery, hand sealing irons, laminating release sheets, drying can covers, and plaque-type belts, as well as conveyor belts. "Armalon" fabrics are also extremely chemical- and heat-resistant.

◆ ◆ ◆

La Choy Food Products, Archbold, O., will expand present production facilities more than 50%. The firm has outgrown present plant facilities despite adding a new shipping dock last year as well as spending over $100,000 in 1955 for a new Food Machinery Company AB Cooker and other additional equipment.

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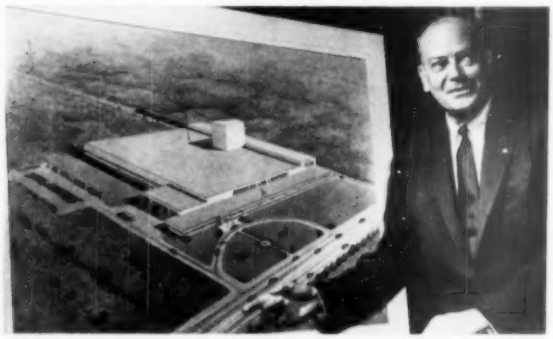

Mr. Wm. C. Stolk, president of American Can Company, shows Chicago press conference (June 11) architect's drawing of new tin-plate processing plant Canco will construct in Chicago area. The plant is part of a $27 million two-year Canco program to install new plate processing techniques as a means of combatting rising tinplate prices. Other facilities for handling plate in huge coils will be installed at Tampa, Fla.; Oakland and Los Angeles, Calif; Baltimore; the New York metropolitan area; in Texas; and at other company locations. The new program for the most part will eliminate use of pre-cut tin and steel plate sheets which the can industry now uses.

Also announced by Canco is a new process that promises to take 98% of the tin out of more than 10 billion tin cans. The development known as margin plating, consists of tinplating only the narrow margins of the steel plate that form the soldered sideseams of the cans. Except for these margins, which aren't more than 3/16" wide, the cans are made entirely of enameled steel plate. The tinplated margins are used only to assure hermetic seals on cans for heat-processed products.

To take full advantage of present and future growth opportunities in food can sales, Canco's general sales department has been expanded to include a special food container division. Mr. Roscoe M. Roberts has been appointed general manager in charge of the new division.

◆ ◆ ◆

Beckman Instruments, Inc., has begun work on a second Atomic Energy Commission order for supersensitive analytical instruments to guard the purity of fissionable material produced by the AEC. The new contract calls for delivery of 6 specially-designed mass spectrometers to the AEC's Portsmouth, O., project. Last year, the Fullerton, Calif., firm completed delivery of 100 of the instruments to the AEC 11 months ahead of schedule. At Portsmouth, the Beckman mass spectrometers, which identify gases by their molecular weights, will be used to detect contaminants in the gaseous diffusion process streams

look for the symbol of the RETORT
YOUR GUARANTEE
OF MATCHLESS QUALITY,
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where uranium is enriched in the fissionable isotope uranium-235.

Beckman also announces acquisition of Lou-Bar Products, 938 Pico Blvd., Santa Monica, Calif., manufacturer of precision components for automatic control systems. Mr. Arthur Buenzli, president of Lou-Bar, will remain on the staff as resident manager.

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Continental Can Company's new $7 million laboratory for research and engineering in Chicago is the largest and most advanced under one roof in the can-making industry. The Research and Development Center, dedicated by Continental president T. C. Fogarty on June 14, includes more than 260,000 sq. ft. of floor space. By the end of the year, 600 people will work here, about half of which will be scientists and engineers. They will develop new containers, new machinery to make and close the containers, and new products for packaging in metal and related materials. Notable among the laboratory's modern precision equipment, are a complete can-making pilot plant and a self-contained can-closing line. Conditions in any can-making factory or canning plant can be duplicated. The new Metal Research and Development Center will serve Continental's 41 Metal Division plants across the country, and 20 field laboratories in the U. S., Canada, and Cuba. The firm maintains 7 other divisional research and development establishments in the U. S. and Canada, in addition to its Central Research and Engineering facilities, also located in Chicago. Mr. Lenvik Yivisaker, general manager of the Metal Division Research and Development Department, is in charge of the metal research and development program in Chicago.

The Refrigeration Research Foundation, formerly located at 200 Midland Bldg., Colorado Springs, Colo., has moved its headquarters to its new building at 12 N. Meade Ave., Colorado Springs.

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Honeymead Products Co., Mankato, Minn., has awarded a contract to Blaw-Knox Co., Chemical Plants Division, Chicago, for the design and erection of what is believed to be the world's largest vegetable oil deodorizing system. The new unit will be capable of producing 10 tank cars of 600,000 lbs. of deodorized soybean oil per day. Supplying oil for this plant will require the processing of 3 million lbs. per day or 18 million bushels of soybeans per year—approximately 8% of the nation's processing capacity. The huge new facility will be completely continuous and automatically controlled, thereby permitting substantial savings over conventional batch or semi-continuous operations. Blaw-Knox currently is constructing a vegetable oil extraction system for Honeymead at Mankato which will be the largest of its type in the world. However, the new deodorizer will require an even greater amount of oil than the giant 1200 tons per day extraction system will produce.

. . . *the human element*

Dr. Chas. N. Frey, consultant and lecturer at MIT and past president of IFT, was awarded the Honor Scroll of the New York Chapter of the American Institute of Chemists at the chapter's annual meeting at the Hotel Commodore, New York City, June 7. Dr. Frey, for many years director of research and development at Standard Brands, Inc., was cited for professional accomplishments throughout a distinguished scientific career. At the same meeting, **Dr. Murray Berdick,** coordinator of research at Evans Research and Development Corp., 250 E. 43rd St., New York City, took office as chapter chairman.

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Mr Robert S. Argyle has been named manager of advertising, sales promotion, and publicity for Dow Corning Corp., Midland, Mich. He succeeds **Mr. Louis S. Putnam,** advertising manager since 1946, who will serve Dow Corning as an editorial and publicity consultant. Mr. Argyle has been on Dow Corning's advertising staff since 1947, and has been a member of the Auxiliary Management Committee for 2 years.

. . . Dow Corning's Argyle . . . new sock for silicones

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The Chemical Sales Division of Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y., announce 5 personnel changes in the Brooklyn headquarters organization and field sales forces. **Mr. Willard K. Thayer,** formerly administrative assistant to the manager of the Division's Medicinal Chemical Department, is field sales manager of the eastern region. **Mr.**

Robert C. Denman, recently on the staff of the Division's Industrial Department, is now department manager. **Mr. John R. Post,** formerly sales representative in Southern California, was assigned to the headquarters staff of the Medicinal Chemical Department in Brooklyn. **Mr. Robert W. Johnson,** who joined the firm in 1953 as a chemical sales representative, has been assigned to serve customers in the Oakland, Calif., area, as well as Northern California, Southern Idaho, Utah, and Western Colorado. **Mr. Robert J. McGrath,** a member of Pfizer's chemical sales force since 1953, will serve as a representative in the Los Angeles and Southern California area.

To accelerate new product development, as well as to broaden its scope in terms of the needs of the industry, Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Co., 260 Madison Ave., New York 16, N. Y., has created a new chemical sales development section separate from its commercial sales department. **Mr. Wm. Gearhart,** formerly chief chemist in charge of the service and development laboratories at Kingsport, Tenn., has been appointed manager of the new section. **Mr. R. B. Herring,** who had served as assistant to Mr. Gearhart, has been promoted to chief chemist in charge of the laboratories, which will continue under Mr. Gearhart's supervision.

. . . Eastman Chemical's Gearhart

Mr. Thos. B. Duff has joined the Market Development Department of American Viscose Corporation's Film Division, 1617 Pennsylvania Blvd., Philadelphia 3, Pa. He will serve as an assistant in the department's package development laboratory.

Mr. G. Radcliffe Stevens, president of Elgin Mfg. Co., Elgin, Ill., announces appointment of **Mr. Edw. Johnson** as vice president in charge of the Elgin-Wrap machine recently acquired from The Globe Company of Chicago. Mr. Johnson was one of the developers of the basic design in 1946, and in his new post will continue to direct and broaden its development versatility. He also will supervise production and sales of the Elgin-Wrap.

. . . Elgin-Wrap's Johnson

Purdue University has conferred an honorary Doctor of Science degree on **Dr. Henry R. Kraybill,** vice president and director of research and education of the American Meat Institute Foundation, Chicago, for outstanding scientific, educational, and administrative achievements. Occasion was the university's 104th commencement exercises in Lafayette, Ind., on June 3. Dr. Kraybill was cited for his devoted services to Purdue University, and for his contributions to biochemistry, plant production, and food processing.

Mr. Edwin P. Nicholson, sales representative of Givaudan-Delawanna, Inc., Givaudan Flavors, Inc., and Sindar Corporation in the New York-New Jersey area, died on May 24 at the age of 57. A long-time member of IFT, he had been associated with the aromatic chemical, perfume, and related industries for 36 years, and in 1955 had celebrated his 25th anniversary with the Givaudan organization.

Dr. Wm. Shockley, right, director of the Shockley Semiconductor Laboratory of Beckman Instruments, Inc., received additional honors at the June commencement ceremonies at Rutgers University when he was awarded the honorary degree of Doctor of Science. He is shown being congratulated by Lewis Webster Jones, Rutgers president. Last year, Dr. Shockley was similarly honored by the University of Pennsylvania.

Appointment of **Mr. Robert W. Smith** as sales manager of the Hoffman-La Roche bulk Vitamin Division, to succeed the late Chester C. Robinson, was announced by Mr. Paul J. Cardinal, vice president in charge of the Division. **Mr. Ralph C. Christiansen** has been promoted to special markets manager. **Mr. Richard D. Zucker,** assistant to the vice president, will devote increased attention to direction of sales control.

Mr. Harold E. Lents has been appointed sales manager of the Refined Oil Sales Department at A. E. Staley Mfg. Co., Decatur, Ill. With the firm for 30 years, he replaces Mr. E. E. Roos who resigned on April 23 to enter other employment in Chicago. **Mr. Ross S. Alverson** has been made office manager in the company's newly completed distribution center at 4616 W. Augusta Blvd., Chicago. Manager of the Chicago branch area is **Mr. Ralph Dombroski.**

. . . Staley's Harold Lents

Mr. Don R. Cowell, public relations director of The Quaker Oats Co., has been elected chairman of the Grocery Manufacturers of America Public Relations Advisory Committee. **Mr. Lee S. Bickmore,** vice president in charge of sales and advertising for National Biscuit Co., was elected vice chairman of the committee which comprises about 25 general executives and public relations officials of member companies.

Applied Physics Corp., 362 W. Colorado, Pasadena 1, Calif., announces appointment of **Mr. R. O. McCloud** as eastern field service engineer. Operating from Washington, D. C., he will provide additional field service on Cary Spectrophotometers in the eastern part of the U. S.

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Promotion of 3 key sales personnel is announced by Mr. Lloyd A. Dixon, Jr., vice president in charge of Rockwell Mfg. Company's Meter and Valve Division, 400 N. Lexington Ave., Pittsburgh 8, Pa. **Mr. Gilbert T. Bowman,** general products manager, and **Mr. J. W. Northcutt,** Southern regional sales manager, have been named assistant vice presidents. Both will make their headquarters in Pittsburgh. **Mr. Jack H. Walters,** product manager, petroleum and industrial liquid meters, will move to Rockwell's Southern regional headquarters in Atlanta, Ga., to succeed Mr. Northcutt.

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Appointment of **Dr. Kenneth W. Brighton,** former associate director of American Can Company's Research Division, as general manager of the New Products Department was announced by Mr. Wm. C. Stolk, Canco president. With the company since 1936, Dr. Brighton in 1951 was named associate director of research at the Maywood, Ill., laboratories, and in March, 1955, assumed the same duties at the new Barrington, Ill., research center, the world's largest food and container research installation.

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Mr. John H. Howard and **Mr. G. J. O'Keefe** have been named to new positions in the Food Industry Department of American Cyanamid Company as a result of expanded activities brought on by the introduction early this year of a new product to extend freshness in poultry. Mr. Howard has been placed in charge of merchandizing activities for the department, and Mr. O'Keefe has been named to direct the sale of the new product, called Aeronize, to poultry processors. Mr. Howard formerly directed Aeronize sales while Mr. O'Keefe was in charge of distributor operations for the company's Animal Feed Department.

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. . . GCMI's DeMerell

Mr. S. B. DeMerell was elected president of the Glass Container Manufacturers Institute, Inc., at the Institute's 12th annual meeting at The Greenbrier Hotel on May 22. **Mr. Edmund F. Ball,** president of Ball Bros. Co., Inc., was elected vice president of GCMI at the industry meeting. Mr. DeMerell is a vice president and a director of Anchor Hocking Glass Corp., Lancaster, O., one of the 74 manufacturers of glass bottles, jars, closures, and supplies which comprise the Institute's membership.

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Dr. Howard O. McMahon, science director of Arthur D. Little, Inc., has been elected vice president of the Cambridge, Mass., industrial research firm. Two nationally recognized awards within 12 months testify to Dr. McMahon's scientific achievements. The Franklin Institute presented him with the Edward Longstreth Medal in 1951 for his contributions to the development of the helium cryostat (an apparatus for liquifying helium that is standard equipment for low temperature laboratories throughout the world). In 1952, the American Ceramics Society honored him with the Frank Forrest Award for his work in the field of thermal radiation from heated glasses.

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Mr. Wm. E. Carey has been appointed vice president and director of sales for Ocoma Foods Co., Omaha, Nebr., division of Consolidated Foods Corp. Mr. Carey comes to Ocoma from Minute Maid Corporation where he was assistant national sales manager.

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Mr. William H. Kanninen has joined the Flavor Laboratories of Polak's Frutal Works, Inc., Middletown, N. Y. He is a graduate of the University of Chicago, and has done graduate study in agricultural biochemistry at the University of Minnesota. Prior to his present appointment, he was connected with Foster D. Snell, Inc., as director of food technology.

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WANTED BY SALT PRODUCER: Technical sales advisor, prefer background in Chemical, Mechanical Engineering or Food Technology. Not over 45. For liaison work between sales and plant development of uses, customer handling equipment, special projects such as feeds, road stabilization, etc. Territory includes California, Oregon, Washington and Arizona. Salary open. REPLY BOX 487, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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AVAILABLE: Chemical Engineer with 9 yrs. exper. supervising food process research and development in large company, and with earlier technical exper. in manufacture of edible fats. Process improvements, developments, economic evaluations, and quality control systems. Desire research and development or quality control position in small to medium food company. REPLY BOX 485, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

FOOD TECHNOLOGIST — for process and product research. Laboratory and plant activity. Graduate degree preferred and/or background in university or industry research. Salary commensurate with training and ability. Write details to Personnel Division, H. J. Heinz Company, P. O. Box 57, Pittsburgh 30, Pa.

AVAILABLE: Food Technologist, M.S., 4 yrs. exper., desires position in production, quality control or research for food company. Best of references. REPLY BOX 486, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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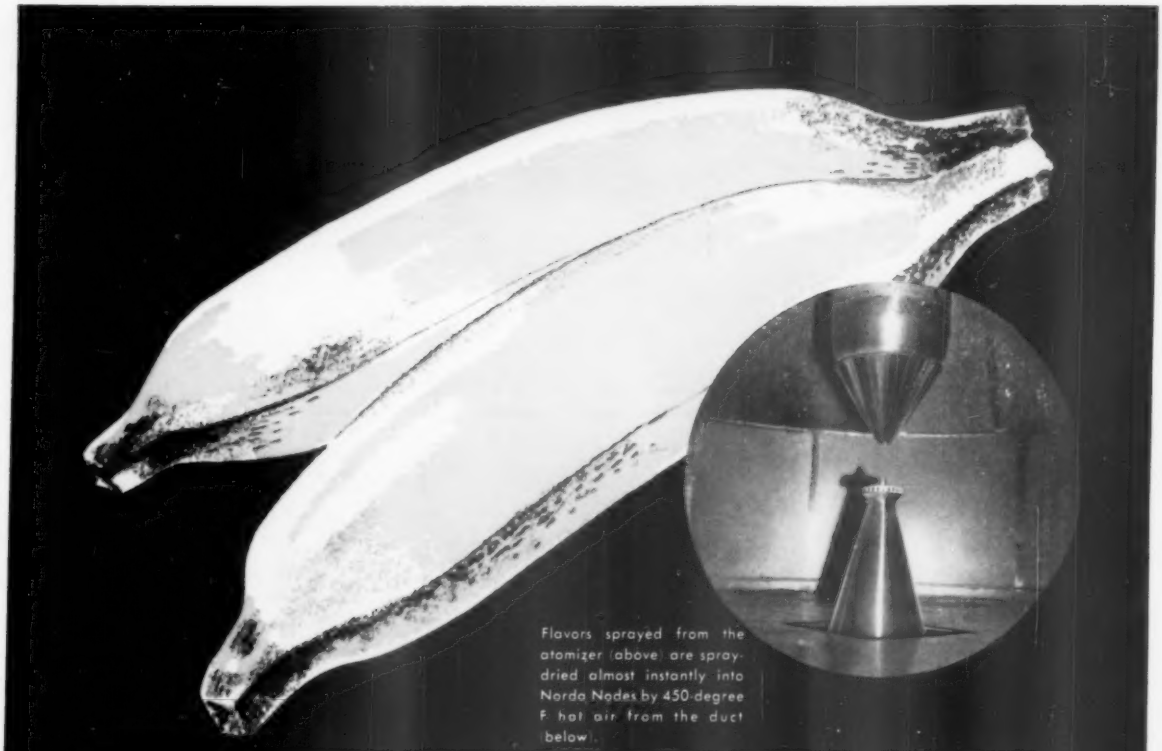

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